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THE IRON ORES OF LAKE SUPERIOR

CONTAINING SOME FACTS OF INTEREST RELATING TO MINING AND SHIPPING OF THE ORE AND LOCATION OF PRINCIPAL MINES

SECOND EDITION

WITH ORIGINAL MAPS OF THE RANGES

BY
CROWELL & MURRAY
CHEMISTS AND METALLURGISTS

THE PENTON PUBLISHING COMPANY
CLEVELAND
1914

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Preface

In presenting the second edition of our book, we wish to acknowledge our thanks to the many friends who have so kindly showed their appreciation of the first edition.

We have gathered together information relating to the Iron Ores of the Lake Superior region, most of which has appeared in the various trade journals, geological reports and scientific society transactions. This information has, however, been widely scattered, and we believe that a compilation of these scattered facts will be appreciated by those interested in the Lake Superior Iron Ores. We have, with the expenditure of a good deal of time and money, redrawn all the maps and believe that they are correct, to date. We have re-written much of the general matter, and corrected mis-statements in the first edition. We have secured the latest descriptions of the mines on the different ranges, and have added data concerning their location, and names of managers, superintendents and sales agents.

We wish to express our appreciation to the various mine owners, ore sales agents and others who have so freely given the information sought, and shall be grateful for any criticism as to statements or statistics in which we may be in error, that such mistakes may be corrected in future editions.

CROWELL & MURRAY.

Cleveland, Ohio, July 1, 1914.

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R REGION.

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gan to attract parrels of ore was the first prts, and was 1913. It was pegan to ship sible by the It Ste. Marie ifficulties and with much opposition from the Congress of the United States. As the interest in Lake Superior ores increased, further discoveries were made. In 1873, ore was found on the Menomonee Range, which lies about 50 miles south of the Marquette Range, and in 1877 ore began to be shipped from this range. The first actual cargo, however, was shipped from Milwaukee, November 11, 1884.

In 1883, ore was found in paying quantities at the Colby Mine on the Gogebic Range. This range lies about 100 miles west of the Marquette Range, and in 1884 became a regular shipper of ore. At about the same time, iron ore was discovered on the Vermilion Range, which lies in the northeastern part of Minnesota about 100 miles north of Duluth. In 1884 this range

became a shipper.

About 30 miles southwest of the Vermilion Range is the Mesabi Range, which extends in an east and west direction for approximately 100 miles. The eastern end of the range lies between Duluth and the Vermilion Range, and the early exploration on the range was mostly confined to this portion, which was not productive. In 1890, however, ore was discovered just north of what is now known as the Mountain Iron Mine, and this discovery was rapidly followed by others. This range has become the largest shipper of ore of any of the Lake Superior Ranges, owing to the large bodies of ore present, and the ease with which it can be taken out. The Cuyuna Range, which is also in Minnesota, about 90 miles west of Duluth, is the youngest range in the Lake Superior region. In 1903 a low grade magnetite ore was discovered near Deerwood, and later, hematite deposits were shown to exist. In 1911 this range began to ship ore and its present prospects are good for becoming a large shipper.

The State of Wisconsin ships considerable iron ore from the Baraboo District. This district is located south of the central part of Wisconsin. Ore was first discovered here in 1900, and

in 1904 the district began regular shipments.

On the Canadian shore of Lake Superior, and in the adjacent territory, there are large areas of iron bearing formation similar to those found on the American side, but as yet most of the exploration in these areas has been disappointing. The oldest productive range in Canada, and the largest shipper, is the Michipicoten Range, which lies on the northeastern shore of Lake Superior, northeast from Michipicoten Island. This range was first opened up in 1897, as a gold mining district, but soon became far more valuable as an iron range. The Helen Mine has been a shipper from this range since 1900. The only other producing mine on the range, the Magpie Mine, made its first shipment in 1913. The Moose Mountain District is located about 30 miles north of Sudbury, Ontario. It was first opened up in 1902. The only mine at present on this range is the Moose Mountain Mine, which began shipping in 1908.

Chapter II. GEOLOGY.

The Lake Superior region is located in Michigan, Wisconsin, Minnesota and Ontario. It contains approximately 181,000 square miles, and is located near the headwaters of three great drainage systems. The largest part of the area is drained by waters that are tributary to Lake Superior and Lake Michigan and thence to the St. Lawrence River. On the west a part of the area is drained by the headwaters of the Mississippi River, and on the north a part of the area is drained by the waters that flow into Hudson Bay. The drainage of the region, however, is very imperfect, and is characterized by numerous small lakes and swamps or muskegs and swift running streams. The surface varies from 602 feet above sea level at Lake Superior to 2,230 feet in northeastern Minnesota, but it usually lies between 1,000 and 1,700 feet above sea level. The principal topographic feature of the region is the Lake Superior basin. This trends in an easterly and westerly direction, and except along the southeastern margin, is nearly walled in by steep escarpments that rise 400 to 800 feet above the surface of the lake. In the adjacent areas the principal ridges and valleys usually trend parallel to the lake. Along the southeastern margin the shore is usually flat and the adjacent area is low lying. The surface of the whole region is mostly covered with a varying thickness of glacial drift, and soil that has resulted from the decomposition of the underlying rocks, is very seldom found.

The iron bearing districts lie at an average elevation of about 1,500 feet above sea level. They contain approximately 3,800 square miles, or about two per cent of the total area of the region. They have been closely studied and the principal geological features in each district have been identified. The intervening areas are not so well known. The region is a part of the southern margin of the great pre-Cambrian area in the northern part of North America. It is bordered and overlapped on the south by Paleozoic rocks of the Mississippi Valley and on the southwest by Cretaceous deposits. The pre-Cambrian rocks include the oldest rocks on the North American continent. They are divided geologically into rocks belonging to two systems known as the Archean or basement complex, and the Algonkian. The Archean system is the oldest and is divided into two series known as the Keewatin and the Laurentian. The Keewatin series is made up of certain basic igneous rocks known as greenstones and green schists, which are associated with subordinate amounts of iron formation, slates and dolomite. They are the oldest rocks in the Lake Superior region. Intrusive into these rocks are certain granites, gneisses, and syenites that belong to the Laurentian age, and superimposed upon them are rocks belonging to the Algonkian system. This system is made up of four sedimentary series which are closely associated with igneous rocks. The three lower series, known as the Lower, Middle and Upper Huronian, consist of iron formations interbedded with slate and quartzite. The upper series, known as the Keweenawan, consists of conglomerates, sandstones, shales and limestones associated with both basic and acid igneous rocks. It contains no iron formations but forms the copper bearing series of Michigan.

The iron formations occur in both the Keewatin and the Huronian series of rocks. They are all very similar and consist of chert or quartz, ferric oxide and small amounts of other iron bearing materials. They represent more or less altered sediments that were derived from rocks rich in iron. This alteration has been due to the chemical action of underground water, and where it has been extensive, the iron formation has been decomposed and ore deposits have been formed. The most important factors in this connection are the structural relations of the iron formation and the presence or absence of impervious rocks at the base or interbedded within the iron formation. These factors have controlled the flow of the underground water and consequently the alteration of the iron formation. As a general rule the ore deposits are found on the slopes or at the base of conspicuous ranges or hills, and are associated with pitching troughs of relatively impervious rocks. These troughs may be formed by greenstone as on the Vermilion Range, by layers of slate within the iron formation as on the Mesabi Range, or by the intersection of slate or quartzite and igneous dikes as on the Gogebic Range. Where the troughs are large and uniform, the alteration of the iron formation has been extensive and large deposits of ore have been formed. Where they are small, irregular or broken, the alteration has been less extensive and the ore deposits are small. The ores were deposited in a hydrated condition but have been partially dehydrated, and vary in different districts from hard to soft ores. The hard ores are dehydrated and may be classified as red, blue and micaceous hematite and magnetite. The soft ores are hematite and limonite.

An outline of the principal features of each district is as

follows:

VERMILION RANGE.

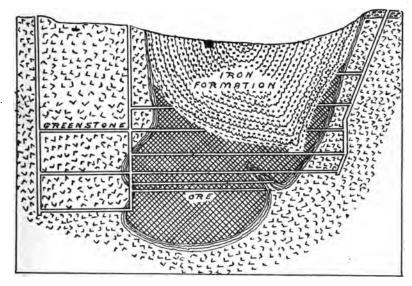
The Vermilion District lies in Northeastern Minnesota and includes the towns of Tower, Soudan and Ely.

The productive formation is the Soudan in the Keewatin division of the Archean. It occurs in narrow belts which are enclosed in greenstone. The whole district is one of complex folding. The ores are hard blue and red hematites. They occur

at or near the contact of the Soudan formation with the greenstone, and owing to the steep pitch the outcrops are small.

The depths of some of the mines are as follows:

Pioneer, 1,466 feet; Savoy, 846 feet; Section 30, 635 feet; Sibley, 1,285 feet; Soudan, 1,249 feet, and Zenith, 1,102 feet.



Vertical Section through Vermilion Ore Deposit and Adjacent Rocks; Chandler Mine, Ely, Minn.

MESABI RANGE.

The Mesabi Range lies in Minnesota, northwest of Lake Superior, and extends in an east and west direction approximately 100 miles. The principal towns are Biwabik, Eveleth, Virginia, Chisholm, Hibbing and Coleraine.

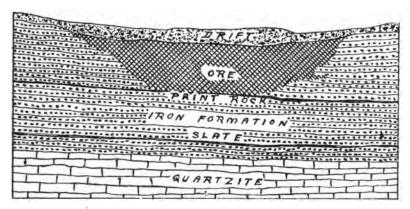
The iron formation is the Biwabik in the Upper Huronian. It lies along the southern slope of a ridge that is known as the Giants or Mesabi Range and has a gentle slope toward the south. The surface is covered with glacial drift, and rock exposures are not common except along the ridge.

The slope of the iron formation is gentle, and the ore deposits are mostly flat lying and have a large horizontal area compared with the deposits on the other ranges. As a general rule, the ore is covered only by glacial drift, and the characteristic method of mining on the range is by open-pit. The impervious basement under the ore deposits is formed by layers of slate or paint rock interbedded with the iron formation.

The ores are mostly soft, hydrated hematites, although some limonite is found. They vary in texture from very fine dust to fairly coarse, hard and granular ore. Towards the Western end of the district, layers of sand are often found interbedded with the ore, forming the so-called "sandy" ores which will have to be concentrated to form ore of commercial grade.

The Mesabi ore deposits are shallow. The depths of some of the mines are as follows:

Albany, 260 feet; Bangor, 323 feet; Canisteo, 221 feet; Fayal, 289 feet; Gilbert, 224 feet; Hill, 225 feet; Norman, 341 feet; Shenango, 295 feet; Susquehanna, 216 feet; Woodbridge, 200 feet.



Generalized Vertical Section through Mesabi Ore Deposit and Adjacent Rocks.

CUYUNA RANGE.

The Cuyuna Range is located in Crow Wing County, Minnesota, approximately 100 miles West of Duluth. The principal towns are Deerwood, Crosby and Brainard.

The iron formation occurs in parallel belts which trend in a general Northeast and Southwest direction. It has not been definitely identified and may belong to the Keewatin, Middle Huronian or Upper Huronian series.

The depths of some of the mines are as follows:

Armour No. 1, 300 feet; Barrows, 150 feet; Kennedy, 295 feet; Meacham, 254 feet.

GOGEBIC RANGE.

The Gogebic Range is a narrow belt of iron formation which lies South of Lake Superior in Michigan and Wisconsin. The most important part of the District lies in Michigan, although

about two-thirds of the formation extends into Wisconsin. The most important towns are Bessemer, Ironwood and Hurley.

The productive formation is the Ironwood in the Upper Huronian series. It occurs as a narrow belt which dips towards the North and has a crenulated outcrop due to a series of minor transverse rolls.

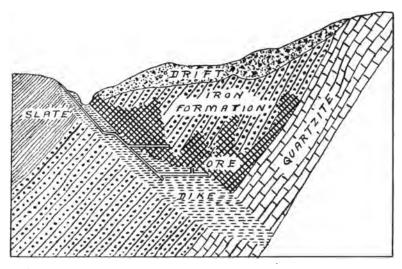
The formation rests on Upper Huronian quartzite and is cut by igneous dikes which combine with the quartzite to form impervious troughs in which the ore bodies were concentrated.

The ores are soft, red and partially hydrated hematites, with

subordinate amounts of hard, blue hematite.

The depths of some of the mines are as follows:

Atlantic, 1,208 feet; Brotherton, 1,157 feet; Cary, 1,195 feet; Newport, 2,200 feet; Norrie-Aurora, 1,736 feet; Sunday Lake, 1,285 feet; Yale, 1,780 feet.



Generalized Vertical Section through Gogebic Ore Deposit and Adjacent Rocks.

IRON RIVER, CRYSTAL FALLS AND FLORENCE DISTRICTS.

The Iron River and Crystal Falls Districts lie in Michigan, and the Florence District in Wisconsin. The principal towns are Iron River, Crystal Falls and Florence.

The iron bearing formations occur in the Upper and Middle Huronian and are respectively known as the Michigamme and the Negaunee formations. The ores are mostly soft, red hematites, although in places, they are hydrated and classed as limonite.

The district is usually included with the Menominee District in the figures for the production of iron ore.

The depths of some of the mines are as follows:

Bristol, 965 feet; Baltic, 553 feet; Florence, 700 feet; Hemlock, 1,015 feet; Hiawatha, 760 feet; Mansfield, 1,517 feet.

MENOMINEE RANGE.

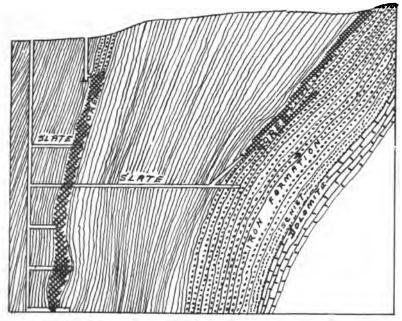
The Menominee District includes the towns of Iron Mountain, Quinnesec and Norway. It lies wholly in the State of Michigan.

The productive iron formation is the Vulcan in the Upper Huronian series. It occurs in several narrow belts, all of which have a steep dip. The principal belt extends about twenty miles in an East and West direction. The formation, where productive, rests on the Lower Huronian dolomite and is covered by Upper Huronian slate. The Middle Huronian series has not been identified in the district.

The ores are usually bluish-black hematites, though subordinate amounts of red and brown banded hematite are found.

The depths of some of the mines are as follows:

Antoine, 135 feet; Chapin, 1,522 feet; Loretto, 800 feet; Millie, 400 feet; Penn Mines, 1,500 feet.

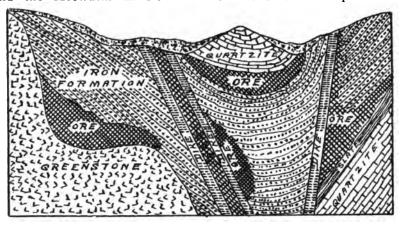


Generalized Vertical Section through Menominee Ore Deposit and Adjacent Rocks.

MARQUETTE RANGE.

The Marquette District is comparatively small. It lies in the State of Michigan and gets its name from the city of Marquette. The principal towns are Ishpeming, Negaunee, Champion and Republic.

The iron formations occur in the Upper and Middle Huronian and the Keewatin division of the Archean. The productive



Generalized Vertical Section through Marquette Ore Deposit and Adjacent Rocks.

formations are the Negaunee in the Middle Huronian and the Ishpeming in the Upper Huronian.

The ores are mostly soft, red hematites although the hard micaceous hematites are important. Subordinate amounts of

magnetite and limonite are found.

The district is cross folded so that the formations are irregularly distributed. In general the iron formation extends in an East and West direction, and the portions of the ore deposits that reach the surface are located on the middle or upper parts of the slopes. The outcrops of ore were conspicuous and led to the early discovery of this district. Some of the bodies are entirely below low lying areas, but in those cases are surrounded by impervious rocks.

The depths of some of the mines are as follows:

American, 1,350 feet; Cambria, 1,160 feet; Lake Superior, 1,228 feet; Negaunee, 885 feet; Republic, 2,050 feet; Stephenson, 560 feet; Washington, 580 feet.

BARABOO DISTRICT.

The Baraboo District is an outlier of the Lake Superior pre-Cambrian rocks and is located in South Central Wisconsin. The principal town is North Freedom. The iron formation is similar to the Middle Huronian but has not been positively identified. The ores are hematites with soft earthy, hard and black, and banded silicious phases. They are stratified and have the same strike and dip as the associated rocks which are found dipping at various angles from nearly horizontal to nearly vertical.

The depth of the Illinois Mine is 475 feet.

MICHIPICOTEN RANGE.

The Michipicoten Range lies in Ontario, Canada, on the Northeastern shore of Lake Superior. The only productive mines are

the Helen and the Magpie.

The iron formation is in the Keewatin series of the Archean. The ore at the Helen Mine is a hard, red, Non-Bessemer Hematite. At the Magpie Mine it is a Siderite, and is calcined and sintered to produce a commercial product. The depth of the Helen Mine is 650 feet, and of the Magpie Mine, 250 feet.

MOOSE MOUNTAIN DISTRICT.

The Moose Mountain District is located in Ontario, 33 miles North of Sudbury.

The ore occurs in the Keewatin division of the Archean. It is mostly finely crystallized magnetite which contains a little hematite. It contains no high grade ore, but material which is necessary to concentrate. The ore is mined by both open cut and underground methods, and at present there is but one productive mine.

Chapter III.

MINERALOGY.

The mine	rals described are:	
Oxides	Hematite, Fe2 O3	Hexagonal
	Magnetite, Fes O4	Isometric
	Martite, Fe2 O3	Isometric
	Ilmenite, (Fe Ti)2 O3	Hexagonal
	Pyrolusite, MnO2	Orthorhombic
Hydroxides	Limonite, Fe2 (OH)6 Fe2 O3	
•	Turgite, Fe4 O5 (OH)2	
	Goethite, FeO (OH)	Orthorhombic
	Manganite, Mn2 O3 (H2O)	Orthorhombic
	Psilomelane, (K2 Ba Mn) O	MnO ₂
	Wad	Composition variable
Carbonates	Siderite, FeCO3	/ Hexagonal
	Rhodochrosite, MnCO3	Hexagonal
Silicate	Rhodonite, MnSiO3	Triclinic
Sulphides	Pyrite, FeS2	Isometric
	Pyrrhotite, Fe6S7 to Fe11S12	Hexagonal
	Marcasite, FeS2	Orthorhombic

The principal iron ores are hematite, limonite, magnetite and siderite. Turgite and goethite are commercially included with limonite. The residues from roasting the sulphides for sulphuric acid manufacture are sometimes used as a source of iron, and some ilmenite is smelted with other ores.

HEMATITE.

Composition: Fe₂ O₃ contains 70.00% iron.

Description: Occurs in masses which are compact, granular, or sometimes micaceous and as loose pulverulent earth. It varies in color from brilliant black metallic to brick red. In all varieties the streak on porcelain is red. The hardness varies from 5.5 to 6.5 and the specific gravity from 4.9 to 5.3.

MAGNETITE.

Composition: Fe₃O₄ contains 72.4% iron.

Description: A black mineral with a black streak on porcelain, and metallic lustre, strongly attracted by the magnet and occurring in all conditions from loose sand to compact coarse or fine grained masses. The hardness varies from 5.5 to 6.5 and the specific gravity from 4.9 to 5.2.

MARTITE.

Composition: Fe₂O₃ contains 70.00% iron.

Description: Differs from hematite in nothing but form. It occurs in octahedrons which it is supposed were derived from the oxidation of magnetite.

ILMENITE (Iron Titanium Compound).

Composition: (Fe Ti)2O3, composition variable.

Description: An iron black mineral usually massive, and in thin plates, imbedded grains or as sand. The streak on porcelain is black to brownish red. The hardness varies from 5 to 6 and the specific gravity from 4.5 to 5.

PYROLUSITE.

Composition: MnO2 contains 63.2% manganese.

Description: A soft manganese ore that occurs granular or massive in more or less radially grouped or parallel bundles of fibres. It varies in color from iron black to dark steel gray, and soils the hands. The streak on porcelain is black or bluish black. The hardness varies from 2 to 2.5 and the specific gravity is 4.8.

LIMONITE.

Composition: Fe₂(OH)₆Fe₂O₃ contains 59.8% iron.

Description: Varies from loose porous bog ore and ochre to compact varieties which often have a black varnish like surface and a fibrous radiated structure. It is recognized principally by its yellowish brown streak on porcelain and absence of crystallization. The hardness varies from 5 to 5.5 and the specific gravity from 3.6 to 4.

TURGITE.

Composition: Fe₄O₅(OH)₂ contains 66.2% iron.

Description: Nearly black and resembles limonite but has a brownish red streak on porcelain. The hardness varies from 5.5 to 6 and the specific gravity from 4.3 to 4.7.

GOETHITE.

Composition: FeO(OH) contains 62.9% iron.

Description: A yellow, red, or brown mineral occurring in distinct crystals often flattened, like scales, or needle like and grouped in parallel position; also occurs massive like yellow ochre. The streak on porcelain is yellow, or brownish yellow. The hardness varies from 5 to 5.5 and the specific gravity from 4 to 4.4.

MANGANITE.

Composition: Mn2O3(H2O) contains 62.5% manganese. Description: A dark steel gray to black mineral with submetallic luster. It occurs massive and in rhombic prisms which are striated longitudinally. The streak on porcelain is reddish or sometimes nearly black. The hardness varies from 4 to 4.5 and the specific gravity from 4.3 to 4.4.

PSILOMELANE.

Composition: (K2BaMn)O MnO2 H2O manganese contents variable.

Description: A hard, massive, black or greenish black mineral that usually occurs associated with pyrolusite. The streak on porcelain is reddish or brownish black. The hardness varies from 5 to 6, and the specific gravity from 4 to 4.4.

WAD (Bog Manganese).

Composition: Contains 20 to 45% manganese and 10 to 25% combined water, with varying amounts of oxides of iron, cobalt or copper.

Description: It is formed in low places from the decomposition of minerals containing manganese. It occurs massive or earthy and varies in color from dull to bluish or brownish black. The streak on porcelain is black or brownish black. The hardness varies from 1 to 6, and the specific gravity from 3 to 4.

SIDERITE.

Composition: FeCO₃ contains 48.2% iron.

Description: Occurs in granular masses of a gray or brown color, or may be black from included carbonaceous matter. The lustre is vitreous to pearly and the mineral is brittle. The streak on porcelain is white or pale yellow. The hardness is 3.5 to 4 and the specific gravity 3.8 to 3.9.

RHODOCHROSITE

Composition: MnCO3 contains 47.8% manganese.

Description: Varies in color from rose red to yellowish gray and brown, and in luster from vitreous to pearly. It occurs crystallized and also granular and massive. The streak on porcelain is white. The hardness varies from 3.5 to 4.5, and the specific gravity from 3.4 to 3.7.

RHODONITE.

Composition: MnSiO3 contains 41.9% manganese.

Description: Usually occurs massive and varies in color from red to brown, green or yellow when pure. The streak on porcelain is white. The hardness varies from 5.5 to 6.5, and the specific gravity from 3.4 to 3.7.

PYRITE.

Composition: FeS2 contains 46.7% iron, 53.3% sulphur. Description: A brass colored metallic mineral frequently in cubic or other isometric crystals, or in crystalline masses; less frequently in non-crystalline masses. The streak on porcelain is greenish black, the hardness 6 to 6.5 and the specific gravity 4.9 to 5.2.

PYRRHOTITE.

Composition: FeeS7 to Fe11S12, composition variable.

Description: Usually a massive bronze metallic mineral which is attracted by the magnet and can be scratched with a knife. The streak on porcelain is grayish black, the hardness 3.5 to 4.5 and the specific gravity 4.5 to 4.6.

MARCASITE.

Composition: FeS2. Same as pyrite.

Description: Differs from pyrite in nothing but form. Crystallizes in orthorhombic forms which have received the names of cockscomb pyrites, spear pyrites, etc. The streak on porcelain is nearly black, the hardness 6 to 6.5 and the specific gravity 4.6 to 4.9.

Chapter IV. PRODUCTION OF ORE.

Methods of Exploration for Iron Ore in the Lake Superior Region.

Exploration for iron ore is as much an engineering problem as mining the ore after it is found. There is, however, a difference between exploration and drilling. Efficiency in exploration means more than a high footage rate per day or a low cost per foot; it concerns every step in the operation from the time a property is first considered as an exploring possibility until the last ore estimate is made or the property abandoned. At no place is there room for haphazard methods or guesswork. That mining companies to a large extent appreciate this is evidenced by the number whose exploration work is placed under the direction of geologists and engineers, while certain exploration companies, doing contract work employ geologists, whose assistance in the interpretation of the drilling records add greatly to the value of the information furnished a client.

The earliest exploration in the Lake Superior iron districts was by means of trenches, test pits and shafts. The few ore bodies which outcrop at the surface were found at comparatively early dates, and as the necessity for deeper and more rapid exploration arose, diamond and churn drills were brought into use; the churn drill being a development of the Mesabi Range. The first diamond drilling was done about 1877 near the city of Ishpeming on the Marquette Range, followed soon after by work on the Vermilion Range in Minnesota and the Menominee and Gogebic in Michigan. On all of these ranges the ore is found to extend to considerable depth, and deep holes, both vertical and angle, are drilled. Considerable underground drilling is done.

The first drill was placed on the Mesabi in 1890, previous exploration having been by test pitting. The flat lying, comparatively shallow formations result in vertical holes of moderate depths.

On the Cuyuna Range exploration has been entirely by the churn and diamond drill. Both vertical and angle holes are drilled, averaging around 300 feet in depth.

Present day methods are the result of over 25 years' experience in which all phases of the subject have been studied from an engineering standpoint. The results are, as a whole, reliable and the cost comparatively low.

In drilling through the surface drift and in soft formations, the churn drill is used. The cutting is done by percussion instead of by rotation as in the diamond drill. A chisel shaped bit is used, having perforations near its cutting edge, while the upper end of the bit is threaded and screwed to the line of drill rods.

which consist of extra heavy pipe. At their upper end the rods are connected to the pump by a flexible coupling and water is forced down through the rods and out of the perforations in the bit, coming up between the rods and the casing pipe and carrying the cuttings to the surface. The churning motion of the rods and bit is secured by passing a rope from the upper end of the line of rods through a sheave wheel in the tripod and down again, winding it two or three times around the drum of the churn drill engine, the end being left loose. The drill runner alternately tightens and slackens this rope while the drum is revolving, thus raising and dropping the bit, the rods being turned slightly after each stroke. In surface drift a 3-inch casing pipe is ordinarily used. Sometimes in deep surface a 4½ or 5-inch pipe is used, but it is better wherever possible, to use the 3-inch and make every effort to carry it through the surface. The casing is driven down by a cylindrical cast iron hammer or drive block, weighing from 250 to 350 pounds. When boulders of any size are encountered they are broken up with dynamite, the casing being raised far enough to be out of danger. electric battery is used to set off the charge. On the Mesabi and Cuyuna Ranges most of the ores are soft and are churn drilled. If soft ore is found immediately below the surface the 3-inch casing is driven a little way into it and stopped, continuing in the ore with a 2-inch casing. If the same casing is used in ore as in the surface, fine sand is likely to run down along the pipe and destroy the sample.

In diamond drilling a line of hollow rods is screwed together, usually in 10-foot lengths, and rotated by an engine through a shaft and gearing. At the bottom of the line of rods is the bit, an annular piece of steel in which are set pieces of carbon otherwise known as black diamonds. The bit is fed forward by means of a screw feed or a piston working in a hydraulic cylinder. As the bit advances it cuts an annular hole, usually 1 9/16-inch in diameter, leaving a 15/16-inch core. Water is forced down through the rods carrying the cuttings away from the bit and to the surface. The core is forced into the lower rod, known as the core barrel, and held there by the core shell and spring and brought to the surface when the rods are pulled. Holes are drilled from surface either vertically or at an angle; from underground horizontally or at any angle either up or down.

Samples of ore are taken at five-foot intervals. The details of sampling methods are outside of the scope of this article. It will be sufficient to say that in general churn drill samples are collected in barrels, four being used, while the cuttings from diamond drilling are caught in some form of a rectangular box, usually divided into three compartments by baffle plates. Samp-

ling is one of the most important parts of exploration and too much attention cannot be given to it.

When it has been decided to start exploration, it is advisable to have the property examined by a geologist, who cruises over the land noting the presence and character of outcrops, locating old drill holes and test pits and taking dip needle readings. This is perhaps not so important on the Mesabi Range where the limits of the iron-bearing formation are well defined, but even here the possibility of finding old drill holes or test pits makes it advisable to have the property examined before drilling is started. Too much drilling is done without taking the fullest advantage of all available knowledge.

The proper interpretation of drilling records is of utmost importance. It seems evident that to secure the best results the samples should be examined, the holes stopped and new locations given by one who has at least some knowledge of the geology of the district, but this is not always done. Too often the drill runner classifies the materials encountered and the samples are not permanently preserved. As long as a person or company retain their interest in a property, the samples from their drilling should not be destroyed. The larger exploration companies provide for fire-proof storage of samples at no cost to their clients, a service which should be utilized. It is certain that less money would be wasted and a higher percentage of success in exploration secured if proper construction were placed on drilling results.

Mining Methods in the Lake Superior Region.

The iron deposits of the Lake Superior region show great variations as to the character and accessibility of the ore. In some cases it is very hard and difficult to mine and in other cases it is very soft. In some cases it occurs close to the surface and can be mined by surface methods and in other cases it occurs, at great depths and must be mined by underground methods. In any case, however, carefully planned systems of mining are permitted due to definite information as to the location and the size, form and grade of the ore body from exploration previous to actual operation. Such exploration is done by drilling and is of the utmost importance in the successful development of a property as it furnishes the basis for all subsequent operations. The methods of drilling and of recording exploration results have been carefully systematized, and as a general rule, estimates based on these records prove remarkably accurate. These methods are described elsewhere in this book.

Compared with other iron ore districts, the Lake Superior region has great natural advantages as the ore deposits are large and comparatively high grade, and the occurrence is such in a

great many cases, as to make them readily accessible for mining. This is especially true for the Mesabi Range where the characteristic occurrence of the ore is in shallow troughs, which have a large horizontal area. As a general rule, these deposits are covered only by glacial drift, and the characteristic method of mining is by steam shovel, although a considerable amount of ore is mined on this range, by underground methods. The production from the Mesabi Range has been enormous. The first shipments were made in 1892, and since that time, up to and including 1913, the range has produced 313,105,968 gross tons, or 49.9 per cent of the entire production from the Lake Superior region since ore was first shipped in 1854. The production from this range during the last 10 years—from 1904 to 1913 inclusive, was 246,444,419 tons, or 64.6 per cent of the total Lake Superior production for this period, and in 1913 it produced 34,038,643 tons or 67.9 per cent of the total production for the year.

Mining methods on the Mesabi Range may be divided into two general classifications, surface and underground. are characteristically soft and friable, and the occurence is such that exploration is comparatively cheap and effective. method of mining used depends on the thickness of the overburden, the size, shape and uniformity, of the ore body, the facilities for approaching the ore body by open cut, the space available for dumping the overburden and the money available for stripping. These factors are determined previous to actual operation, and the propriety determined of mining by surface or underground methods. If possible, steam shovel operation is given the preference over underground methods of mining, unless the amount of overburden is too great compared with the amount of ore available. At the present time, the economical limit of stripping is generally considered to be one yard of overburden to one ton of ore where the vertical depth of the overburden does not exceed two feet of stripping to one foot of ore. The character of the overburden must also be taken into consideration, and allowance made for difficult stripping, and in any case, approximately 150 feet is taken as the maximum depth of overburden that can be economically removed.

Mining ore by steam shovel has reached a high state of development on the Mesabi Range. The system is simple, but the procedure is often complicated by internal and external factors that cause irregular operation in the pit and fluctuations in the cost of mining. The ore deposits are often irregular in form and grade, and the track arrangement and shovel operations are often subject to considerable variation to meet individual conditions, and to produce the grades of ore desired. Steam shovel operation, however, has many advantages over underground systems of mining, and if the estimated cost of mining by this method is

equal to, or even slightly exceeds the estimated cost of mining by underground methods, it is usually chosen as the most desirable method of operation. Mines operated by steam shovels are capable of large outputs per day, and the tonnage produced per man employed, is very much greater than is possible by underground methods, so that large productions can be maintained with a comparatively small operating crew. Steam shovel operation also has the advantage that the production can be quickly increased or decreased to conform with market conditions, and that if desired, the property so operated can remain idle during periods of depression without heavy charges for maintenance, and operations quickly resumed without especial preparation or expense.

The underground methods used on the Mesabi Range consist of caving systems that allow the surface to settle as the ore beneath is removed. The method most commonly used is known as the top slicing system, and is subject to various modifications to meet individual conditions. The underground development essentially consists of a shaft, shaft station and pump room, a main haulage level and raises, drifts and cross cuts on the sublevels. As much as possible of this work is done in ore. In mining, raises are put up to barren or caved ground and drifts are run in ore from the tops of the raises, parallel to the main drifts below. These drifts are extended until they reach the limits of the ore body or barren ground that has already been caved. Cross cuts are then driven from the ends of the drifts to the limits of the ore body, and a mat of timber is laid on the floor. The timbers supporting the cross cuts are then blasted out and the overburden is allowed to cave. This process is repeated until the pillars are entirely removed and work on a new slice is begun, and is continued until the entire deposit has been mined. The system is adapted to large deposits that occur so that steam shovel mining cannot be employed. The advantages of the method over other methods of underground mining are that the cost of mining is low, and the percentage of ore extracted is The development is simple and opportunity is given for sorting ore and keeping various grades separate. The disadvantages are that the number of working places is limited, and consequently, the production is curtailed. Considerable timber is required, and the timber and ore both require considerable handling.

A combination of surface and underground methods of mining, known as the milling system is sometimes used in connection with both surface and underground methods. In this system the surface is stripped as in steam shovel mining, and the ore is broken and falls into mills or raises, that extend to the surface from underground workings. The ore is then transported to the shaft, and is hoisted as in underground methods.

On the other ranges the ore deposits occur at such depths that surface methods of mining can be used in only a few isolated cases. These methods are similar to those already described for the Mesabi Range. In most cases underground methods of mining must be resorted to, and the ores are usually hoisted from depths that vary from 500 to 1,500 feet, although in one case, the mine workings extend to a vertical depth of 2,200 feet, and are still in ore. The methods used depend on the size, form and attitude of the ore bodies, and the character of the ore. They may be divided into two general classifications—caving and stoping methods.

The caving methods of mining are best adapted to deposits having a comparatively large horizontal area, and consist of top slicing, sub-drifting and various modifications to meet individual requirements. The top slicing system is generally used with ores that are more or less mixed in grade, and that are comparatively easy to cave, while the sub-drift system of mining is used with harder formations and ores of uniform grade as it is difficult to separate various grades by this system. The development outside of the ore body is the same in either system of mining Shafts are sunk some distance from the ore deposits, and permanent haulage ways are driven in solid rock to the ore deposit. The method of procedure then with the top slicing system is the same with some modifications as that previously described for the Mesabi Range. In the sub-drift system of mining the main levels are driven near the walls of the deposit and drifts are driven at intervals cross-cutting the deposit. Raises are then put up and sub-drifts are driven parallel to the drifts on the main level until the raises break through into the level above and the sub-drifts have been connected with other sub-drifts. By this means, the ore between two main levels is honey-combed with vertical and horizontal passages, which are separated by pillars of ore. The pillars of ore are then gradually removed, keeping the work on the upper sub-drifts further advanced than on the lower and controlling the settlement of the overburden by a mat of timbers that is constantly being added to as the deposit is mined. This operation is known as "stripping" and as soon as it is completed down to a main level, that level is abandoned and all communication with the sub-drifts below must be through the lower level. The usual procedure is to sub-drift between this level and the next level below, so as to have these pillars ready for stripping as soon as operations are completed above. The advantage of this method of mining over the top slicing system is, that large outputs are possible owing to the greater number of working places.

Various stoping systems are used in the Lake Superior region depending upon the attitude and the size of the ore body and

the character of the ore. In general, these systems are best adapted to comparatively narrow and rather steeply inclined deposits, but they are sometimes used in combination with caving systems. A discussion of the various systems of stoping is beyond the scope of this book.

TRANSPORTATION OF LAKE SUPERIOR IRON ORES.

The transportation of the Lake Superior iron ores from the mines to the furnaces is accomplished by rail and water. Transportation facilities have increased by leaps and bounds since the days of wagons and sleds. Sailing vessels, which were the first means of water transportation, have practically disappeared from the Great Lakes, and the modern ore carriers have developed into a class of boats whose equal in bulk carriers, are not found anywhere else. The railroad facilities have kept pace with the water transportation, and at present the ore is moved from the mines to the docks very rapidly and in very long trains.

At the terminal yards, these trains are broken up into "blocks," which are held until orders for shipment are received. The ore selected for a given cargo is then dumped into pockets on the dock and, when the boat is in place, is delivered into the hold of the boat by means of gates and hinged chutes. A number of pockets are emptied at the same time and the boats are loaded rapidly. The increase in the cargo capacity of the boats is shown as follows:

In	1852	the	largest	cargo	was	5	barrels.
In	1856	the	largest	cargo	was	400	tons.
					was		tons.
In	1876	the	largest	cargo	was	1,360	tons.
					was		tons.
In	1896	the	largest	cargo	was	3,843	tons.
In	1900	the	largest	cargo	was	7,450	tons.
In	1910	the	largest	cargo	was (Record cargo)	13,410	tons.
In	1913	the	largest	cargo	was	11,250	tons.

The unloading at the lower lake ports is done by several types of machines, directly from the boats, and the ore is placed either in cars or on stock piles for future shipment. At the furnace plants located directly on the lakes, the ore is unloaded from the boat directly on the furnace stock-pile. Ore for furnaces inland, is moved by rail from the lake ports.

The unloading machines are naturally placed along some protected water front, and are designed and operated so as to unload ore rapidly. In the early days of the ore trade, and up to a comparatively recent time, a great deal of hand labor and time were

required to unload a boat. The buckets were small and were filled by shovels and the same machine was used for both unloading and stockpiling the ore. Recent practice practically eliminates hand labor in the hold of a boat, and greatly increases the speed of unloading, as not only the capacity of the bucket has been increased, but the number of trips that it can make has also been increased as storage bridges are used for stockpiling the ore, and the distance that the unloading buckets have to travel is much less than with the older machines.

The cost of transporting the ore from the mines to the lower lake ports includes the charge on the rail shipments from the mine to the dock and the charge on the boat shipment from the dock to the lower lake ports. The rail freight from the Marquette Range to Marquette in 1855 was \$3.00 per ton. In 1866 Marquette Range ore also began to be shipped to Escanaba. The freight rate was \$1.55 per ton. These rates were gradually reduced till 1899, when the rate to Marquette was 25 cts. per ton, and to Escanaba 40 cts. per ton. These rates were in force until 1905, when the Marquette rate was raised to 32 cts., the Escanaba rate remaining at 40 cents.

The first freight rate for Menominee ore to Escanaba was 85 cts. per ton. This was in 1887. The rate was gradually reduced until 1899, when the present rate, 40 cts. per ton, went into effect. In 1877, the rate from the Gogebic Range to Ashland was established at 80 cts. per ton. This was gradually reduced until 1898 when the present rate of 40 cts. per ton was established. In 1892, the rates from the Vermilion and Mesabi Ranges were established as follows: Mesabi Range to Duluth 80 cts. per ton, to Superior 80 cts. per ton, to Two Harbors 80 cts. per ton, from Ely to Two Harbors \$1.00 per ton, from Tower and Soudan to Two Harbors 90 cts. per ton. These rates were reduced in 1912 to 60 cts.

On the following pages will be found complete tables showing the freight rates from the various iron ore ranges in the Lake Superior region to the shipping points, from the opening of each range to date. There is also shown a table giving the freight rates on iron ore from the shipping points to the lower lake ports. Rail Freights on Iron Ore from the Mines to Lake Shipping Points

V	Marquet	te Range	Menom- inee		Gogebic Range Ashland		Mesabi and Vermilion			. To	
Year	Marquette	Escanaba	Range Escanaba	Wis. Cent. R. R.	C. & N.W R. R.		Superi	or Ely	Two H Fro Tower	on Other	
1855	\$3.00								Souda	n Points	
1856											
1857	1.27										
1858	.87										
1859											
1860											
861											
1862											
1863											
1864											
1865		61 FF									
1866 1867		\$1.55									
1868		1.80 1.80									
1869		1.85									
1870		1.85									
1871		1.70									
872		1.70									
1873		2.00									
1874		2.00									
1875		1.25									
1876		1.15									
1877		1.15									
1878		1.15									
1879		1.15									
1880		1.25									
1881		1.25									
1882		1.25									
1883 1884		1.10									
1885		.80 .80									
1886		.80							-		
1887		.80	\$0.85	\$0.80	\$0.80						
1888		.70	.75	.70	.70						
1889		.70	.75	.70	.70 .70						
1890		.70	., 5	.70	., 0						
1891		.70	.70	.65	.65						
1892		.65	.70	.65		\$0.80	\$0.80	\$1.00	\$0.90	\$0.8	
1893		.65	.70	.65	.65	.80	.80	1.00	.90	8.	
1894		.52	.70	.52	.65	.80	.80	1.00	.90	.8	
1895		.52	.52	.52	.52	.80	.80	1.00	.90	.8	
1896		.52	.52	.52	.52	.80	.80	1.00	.90	.8	
1897		.52	.52	.45	.52	.80	.80	1.00	.90	.8	
1898		.40	.45	.40	.45	.80	.80	1.00	.90	.8	
1899 1900		.40	.40	.40	.40	.80	.80	1.00	.90	.8	
1901		.40	.40	.40	.40	.80	.80	1.00	.90	.8	
902		.40 .40	.40 .40	.40 .40	.40	.80	.80	1.00	.90	.8	
1903	25	.40	.40 .40	.40 .40	.40 .40	.80	.80	1.00	.90	.8	
904		.40	.40 .40	.40 .40	.40 .40	.80 .80	.80 .80	1.00	.90	.8	
		.40	.40	.40	.40 .40	.80 .80	.80 .80	1.00 1.00	.90 .90	8. 8.	
) .J <i>Z</i>		.40	.40	.40 .40	.80	.80	1.00	.90 .90	.8. 8.	
1905	.32	.40				.80	.80	1.00	.90	.8.	
1905 1906 1907	32	.40 .40		.40	.40				.70	.0	
1905 1906 1907 1908	32	.40	.40	.40 .40	.40 .40			1.00	90	õ	
1905 1906 1907 1908 1909	32 32 33 34 35 36 37 38		.40 .40	.40	.40	.80	.80	1.00	.90	.8	
1905 1906 1907 1908 1909 1910	32 32 33 34 35 36 37 37 38 38 39 30 30 30 30 30 30 30 30 30 30 30 30 30	.40 .40 .40 .40	.40	.40 .40	.40 .40	.80 .80	.80 .80	1.00 1.00	.90 .90	.8 8.	
1905 1906 1907 1908 1909 1910	32 32 33 33 34 35 36 37 37 38 38 38 38 38 38 38 38 38 38 38 38 38	.40 .40 .40 .40 .40	.40 .40 .40 .40 .40	.40 .40 .40	.40 .40 .40	.80 .80 .80	.80 .80 .80	1.00 1.00 1.00	.90 .90 .90	8. 8. 8.	
1905 1906 1907 1908 1909 1910 1911	32 32 33 34 35 36 37 37 38 38 39 31 32 32 32 32 32 32 32 32 32 32 32 32 32	.40 .40 .40 .40 .40	.40 .40 .40 .40 .40 .40	.40 .40 .40 .40 .40	.40 .40 .40 .40 .40	.80 .80	.80 .80 .80 .80	1.00 1.00 1.00 1.00	.90 .90 .90	.8 .8 .8	
1905 1906 1907 1908 1909 1910	32 32 33 32 34 35 36 37 38 38 38 39 30 31 32 32 32 32 32 32 32 32 32 32 32 32 32	.40 .40 .40 .40 .40	.40 .40 .40 .40 .40	.40 .40 .40 .40	.40 .40 .40 .40	.80 .80 .80 .80	.80 .80 .80	1.00 1.00 1.00	.90 .90 .90	.8 .8 .8 .6	

Lake Freight Rates on Iron Ore from Ports Named to Lake Erie

YEAR	ESCANABA	MARQUETTE	ASHLAND AND OTHER PORTS AT HEAD OF LAKE SUPERIOR
1855		\$3.00	
1856		3.00	
1857		2.67	
1858		2.09	
1859		2.00	
1860		2.00	
1861		2.21	
1862		2.89 3.19	
1863 1864		3.37	
1865		3.23	
1866	\$3.77	4.17	
1867	3.28	2.98	
1868	2.44	3.11	
1869	2.43	3.21	
1870	2.40	3.06	
1871	2.07	2.83	
1872	2.50	3.59	
1873	2.74	3.44 3.84	•
1874 1875	No shipment No shipment	2.87	
1876	No shipment	2.54	
1877	No shipment	1.40	
1878	. 8 5	1.26	
1879	1.07	1.61	
1880	1.77	2.50	
1881	1.55	2.25 1.50	
1882 1883	1.22 1.11	1.30	
.1884	.98	1.21	
1885	.84	1.01	\$1.20
1886	1.16	1.35	1.49
1887	1.49	1.75	2.11 1.34
1888 1889	.97 1.00	1.22 1.14	1.29
1890	.99	1.16	1.26
1891	.74	.96	1.05
1892	.87	1.06	1.20
1893	.70	.85	.88
1894	.53	.70	.79
1895	.64	.83 .80	.96 .91
1896 1897	.61 .45	.60	.63
1898	.48	.60	.61
1899	.72	.84	.95
1900	.85	.94	1.05
1901	.62	.74	.84
1902	.59	.68	.76
1903 1904	.63 .54	.73 .61	.83 .70
1905	.60	.70	.76
1906	.60	.70	.75
1907	.60	. 7 0	.75
1908	.50	.60	.65
1909	.50	.60	.65 70
1910 1911	.55 .45	.65 .55	.70 .60
1912	.45 .35	.55 .45	.50
1913	.40	.50	.55
1914	.35	.45	50

Table Showing Shipments of Lake Superior Iron Ore from Opening of Each Range to Date.

Year.	Marquette.	Menominee.	Gogebic.	Vermilion.	Mesabi.	Mayville.
1854*	3,000			• • • • • • •	• • • • • • •	• • • • • •
1855	1,449		• • • • • • •	• • • • • • •	• • • • • • •	• • • • •
1856	36,343					• • • • • •
1857	25,646	• • • • • • • • •	• • • • • • • •		• • • • • • • •	• • • • • •
1858	15,876	• • • • • • • •	• • • • • • • •	• • • • • • • •		• • • • • •
1859	68,832	• • • • • • • • • • • • • • • • • • • •		• • • • • • • •	• • • • • • • • • • • • • • • • • • • •	• • • • • •
1860	114,401	• • • • • • • •	• • • • • • • • •	• • • • • • • •	• • • • • • • • • • • • • • • • • • • •	• • • • • •
1861	49,909	• • • • • • • •	• • • • • • • •			• • • • • •
1862	124,169	• • • • • • •	• • • • • • • • •	•••••	• • • • • • • • • • • • • • • • • • • •	•••••
1863	203,055		• • • • • • • • • • • • • • • • • • • •	• • • • • • • •	• • • • • • • • • • • • • • • • • • • •	
1864	243,127	.:				
1865	236,208	• • • • • • • •				
1866 1867	278,796 473,567					
1868	491,449					
1869	617,444					
1870	830,940					
1871	779,607					
1872	900,901					
1873	1,162,458					
1874	919,557				•••••	
1875	891,257				•••••	
1876	992,764					
1877	1,010,494	10,405		•••••		
1878	1,033,082	82,824				
1879	1,130,019	247,135				
1880	1,384,010	560,950				
1881	1,579,834	738,987				
1882	1,829,394	1,170,819				
1883	1,305,425	1,078,551				
1884	1,558,034	896,282	1,022	62,124		
1885	1,428,907	692,950	119,860	225,484		
1886	1,615,238	892,148	753,362	304,396	• • • • • • •	• • • • •
1887	1,848,934	1,196,043	1,322,878	394,252	• • • • • • •	• • • • • •
1888	1,923,727	1,191,101	1,437,096	511,953	• • • • • • •	• • • • • •
1889	2,642,813	1,796,754	1,988,394	844,682	• • • • • • • • •	• • • • • •
1890	2,993,664	2,282,237	2,847,810	880,014	• • • • • • • •	• • • • • • •
1891	2,512,242	1,824,619	1,839,574	894,618		
1892	2,666,856	2,261,499	2,971,991	1,167,650	4,245	9,044
1893	1,834,683	1,466,197	1,275,438	820,621	613,620	7,925
1894	2,060,260 2,097,838	1,137,949 1,923,798	1,809,468 2,547,976	948,513 1,077,838	1,793,052 2,781,587	10,511 16,472
1895 1896	2,604,221	1,560,467	1,799,971	1,088,090	2,882,079	13,144
1897	2,715,035	1,937,013	2,258,236	1,278,481	4,275,809	10,546
1898	3,125,039	2,522,265	2,498,461	1,265,142	4,613,766	18,151
1899	3,757,010	3,301,052	2,795,856	1,771,502	6,626,384	19,731
1900	3,457,522	3,261,221	2,875,295	1,655,820	7,809,535	20,986
1901	3,245,346	3,619,053	2,938,155	1,786,063	9,004,890	22,400
1902	3,868,025	4,612,509	3,654,929	2,084,263	13,342,840	23,338
1903	3,040,245	3,749,567	2,912,708	1,676,699	12,913,742	36,749
1904	2,843,703	3,074,848	2,398,287	1,282,513	12,156,008	46,120
1905	4,215,572	4,495,451	3,705,207	1,677,186	20,158,699	60,588
1906	4,057,187	5,109,088	3,643,514	1,792,355	23,819,029	77,471
1907	4,388,073	4,964,728	3,637,102	1,685,267	27,495,708	23,610
1908	2,414,632	2,679,156	2,699,856	841,544	17,257,350	71,341
1909	4,256,172	4,875,385	4,088,057	1,108,215	28,176,281	82,759
1910	4,392,726	4,237,738	4,315,314	1,203,177	29,201,760	91,682
1911	2,833,116	3,911,174	2,603,318	1,088,930	22,093,532	115,629
1912	4,202,308	4,711,440	5,006,266	1,844,981	32,047,409	104,031
1913	3,966,680	4,965,604	4,531,558	1,566,600	34,038,643	145,010
Total	107,298,821	89,039,007	77,276,959	34,828,973	313,105,968	1,027,238

^{*}Prior to 1854.

Michipicoten.	Baraboo.	Moose Mt.	Cuyuna.	Total.	Year.
				3,000	*1854
				1,449	1855
				36,343	1856
				25,646	1857
				15,876	1858
				68,832	1859
				114,401	1860
• • • • • • •			• • • • • • •	49,909	1861
• • • • • • •	• • • • • • • •	• • • • • • •	• • • • • • • •	124.169	1862
• • • • • • • •	• • • • • • • •	• • • • • • • •	• • • • • • • •	203,055	1863
• • • • • • • •	• • • • • • • •	• • • • • • • •	• • • • • • • •	243,127	1864
• • • • • • •		• • • • • • • •	• • • • • • •	236,208	1865 1866
• • • • • • • •	• • • • • • • •	• • • • • • • • •	• • • • • • • •	278,796 473,567	1867
• • • • • • • •	• • • • • • • • •	• • • • • • • • •	• • • • • • • • • • • • • • • • • • • •	491,449	1868
•••••	• • • • • • • • •	•••••	• • • • • • • • • • • • • • • • • • • •	617,444	1869
• • • • • • • • • • • • • • • • • • • •	• • • • • • • •	• • • • • • • • • • • • • • • • • • • •	• • • • • • • • •	830,940	1870
• • • • • • • • • • • • • • • • • • • •				779,607	1871
• • • • • • • • • • • • • • • • • • • •				900,901	1872
• • • • • • • • • • • • • • • • • • • •				1,162,458	1873
				919,557	1874
				891,257	1875
•••••				992,764	1876
				1,020,899	1877
				1,115,906	1878
				1,377,154	1879
• • • • • • •				1,944,960	1880
• • • • • • •				2,318,821	1881
• • • • • • •		• • • • • • •	• • • • • • •	3,000,213	1882
• • • • • • •	• • • • • • • •	• • • • • • • •	• • • • • • •	2,383,976	1883
• • • • • • •	• • • • • • • •	• • • • • • • •	• • • • • • • •	2,517,462	1884
• • • • • • • •	• • • • • • • • •	• • • • • • • •	• • • • • • • •	2,467,201	1885
•••••	• • • • • • • • • • • • • • • • • • • •	• • • • • • • •	• • • • • • • •	3,565,144	1886 1887
		• • • • • • • • • • • • • • • • • • • •	• • • • • • • •	4,762,107 5,063,877	1888
• • • • • • • • • • • • • • • • • • • •				7,272,643	1889
• • • • • • • • • • • • • • • • • • • •				9,003,725	1890
				7,071,053	1891
				9,081,285	1892
• • • • • • • •				6,018,484	1893
				7,759,753	1894
				10,445,509	1895
• • • • • • •	• • • • • • • •	,		9,947,972	1896
• • • • • • • •	• • • • • • • •		• • • • • • • •	12,475,120	1897
• • • • • • • •	• • • • • • • • •	• • • • • • • •		14,042,824	1898
	• • • • • • • • •	• • • • • • •	• • • • • • • •	18,271,535	1899
65,000	• • • • • • • •	• • • • • • • •	• • • • • • • •	19,145,379	1900
232,531	• • • • • • • • • • • • • • • • • • • •	• • • • • • • •		20,848,438	1901
302,510 203,119	• • • • • • • • • • • • • • • • • • • •	• • • • • • • •	· • • • • • • • • • • • • • • • • • • •	27,888,414	1902
118,355	47,922	• • • • • • • • • • • • • • • • • • • •	• • • • • • • • • • • • • • • • • • • •	24,532,829 21,967,756	1903
169,527	71,413			34,553,643	1905
121,556	67,118			38,687,318	1906
142,832	72,180			42,409,500	1907
148,421	51,108	2,557		26,165,965	1908
170,065		26,199		42,783,133	1909
115,790		71,784		43,629,971	1910
148,627		6,749	147,431	32,948,506	1911
48,838		49,339	305,111	48,319,723	1912
41,497		95,518	733,021	50,084,131	1913
2,028,668	309,741	252,146	1,185,563	626,353,084	Total

^{*}Prior to 1854.

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Michipicoten.	Baraboo.	Moose Mt.	Cuyuna.	Total.	Year.
		Moose Mt.		3,000	*1854
•••••				1,449	1855
•••••				36,343	1856
				23,646	1857
				15,876	1858
				68,832	1859
				114,401	1860
				49,909	1861
				124.169	1862
				203,055	1863
• • • • • • • • • • • • • • • • • • • •				243,127	1864
• • • • • • • •		• • • • • • •		236,208	1865
• • • • • • • • • • • • • • • • • • • •	• • • • • • • •	• • • • • • • • • • • • • • • • • • • •	• • • • • • • •	278,796	1866
• • • • • • • • •	• • • • • • • •	• • • • • • •	• • • • • • • •	473,567	1867
• • • • • • • •	• • • • • • • •	• • • • • • • •	• • • • • • •	491,449	1868 1869
• • • • • • • • • • • • • • • • • • • •	• • • • • • • • •	• • • • • • • • •	• • • • • • • • • • • • • • • • • • • •	617,444	1870
•••••	• • • • • • • • • • • • • • • • • • • •	• • • • • • • •	• • • • • • • • • • • • • • • • • • • •	830,940 779,607	1871
• • • • • • • •	• • • • • • • • • • • • • • • • • • • •	• • • • • • • • • • • • • • • • • • • •	• • • • • • • • •	900,901	1872
		•••••		1,162,458	1873
				919,557	1874
• • • • • • • • • • • • • • • • • • • •				891,257	1875
				992,764	1876
				1,020,899	1877
				1,115,906	1878
				1,377,154	1879
				1,944,960	1880
• • • • • • •				2,318,821	1881
• • • • • • • • • • • • • • • • • • • •		• • • • • • • •		3,000,213	1882
• • • • • • •	• • • • • • • •	• • • • • • •	• • • • • • •	2,383,976	1883
• • • • • • • • • • • • • • • • • • • •	• • • • • • • • •	• • • • • • • •	• • • • • • •	2,517,462	1884
• • • • • • • •	• • • • • • • • •	• • • • • • • •	• • • • • • • •	2,467,201	1885
•••••	• • • • • • • • • • • • • • • • • • • •	• • • • • • • • •	• • • • • • • •	3,565,144	1886
•••••			• • • • • • • • •	4,762,107 5,063,877	1888
•••••			• • • • • • • • • • • • • • • • • • • •	7,272,643	1889
				9,003,725	1890
				7,071,053	1891
				9,081,285	1892
• • • • • • •				6,018,484	1893
• • • • • • •				7,759,753	1894
• • • • • • •	• • • • • • • •	• • • • • • • •		10,445,509	1895
• • • • • • •	• • • • • • • •	,	• • • • • • • •	9,947,972	1896
• • • • • • •	• • • • • • • • •	• • • • • • • •	• • • • • • • •	12,475,120	1897
• • • • • • • • •	• • • • • • • •	• • • • • • • •	• • • • • • • • •	14,042,824	1898
٠٠٠٠٠٠٠ دو موم	• • • • • • • • • • • • • • • • • • • •	• • • • • • •	• • • • • • • •	18,271,535	1899
65,000 232,531	• • • • • • • • • • • • • • • • • • • •	• • • • • • • • • • • • • • • • • • • •	• • • • • • • • • • • • • • • • • • • •	19,145,379	1900
302,510				20,848,438 27,888,414	1901
203,119				24,532,829	1903
118,355	47,922			21,967,756	1904
169,527	71,413			34,553,643	1905
121,556	67,118			38,687,318	1906
142,832	72,180			42,409,500	1907
148,421	51,108	2,557		26,165,965	1908
170,065		26,199		42,783,133	1909
115,790		71,784		43,629,971	1910
148,627		6,749	147,431	32,948,506	1911
48,838	• • • • • • • •	49,339	305,111	48,319,723	1912
41,497	•••••	95,518	733,021	50,084,131	1913
2,028,668	309,741	252,146	1,185,563	626,353,084	Total

*Prior to 1854.

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Chapter V. DOCK EQUIPMENT.

Iron Ore Unloading Docks at the Lower Lake Ports.

ASHTABULA.

Dock: Pittsburgh, Youngstown & Ashtabula R. R. Co.

Operating Company: Ohio & Western Pennsylvania Dock Co.

Superintendent: J. M. Amsden.

Description: The dock is equipped with six electric Hoover & Mason unloading machines with six-ton automatic buckets and is operated double shift. It has an unloading capacity of 30,000 tons per 20-hour day, and the ore is weighed by machine hopper scales. The dock is equipped with one storage bridge with a ten-ton clam, and has a storage capacity of 800,000 tons.

Dock: Superior.

Operating Company: The Ashtabula & Buffalo Dock Co.

Manager: H. S. Pickands.

Superintendent: E. O. Whitney.

Description: The dock is equipped with four electric Hulett's with 15-ton automatic buckets and is operated double shift. It has an unloading capacity of 40,000 tons per 20-hour day. The ore is weighed by machine hopper scales. The dock is equipped with one storage bridge with 15-ton clam, and has a storage capacity of 1,000,000 tons.

Dock: The Pollock-Becker Co. (Formerly Union).

Operating Company: The Pollock-Becker Co.

Manager: C. A. Williams.
Superintendent: J. H. Burton.

Description: The dock is equipped with four electric Hulett machines with 15-ton automatic buckets, and is operated double shift. It has an unloading capacity of 44,000 tons per 20-hour day, and the ore is weighed by machine hopper scales. The dock is equipped with one storage bridge with 17-ton clam, and has a capacity of 1,000,000 tons.

BUFFALO.

Dock: Buffalo, Rochester & Pittsburgh.

Operating Company: Buffalo, Rochester & Pittsburgh R. R. Co. Description: The dock is equipped with two hydraulic Hulett machines, 12-ton automatic buckets, and has an unloading capacity of 7,500 tons per 10-hour day. It is usually operated on single shift. The ore is weighed by the railroad company on railroad scales.

Dock: Buffalo Union Furnace Co.

Operating Company: Buffalo Union Furnace Co.

Manager: B. Marron.

Superintendent: J. J. Sammon.

Description: The dock is equipped with two McMyler steam power, and four Brown electric machines, with 2 and 4-ton automatic buckets, respectively, and has an unloading capacity of 8,000 tons per 20-hour day. It is operated both double and single shift, and has a storage capacity of 300,000 tons.

Dock: Lackawanna Steel Co.

Operating Company: Lackawanna Steel Co.

General Superintendent: G. F. Downs. Dock Superintendent: C. Jacobson.

Description: The dock is equipped with five electric Hulett machines with 10-ton automatic buckets, and has an unloading capacity of 20,000 tons per 20-hour day. It is operated double shift, and the ore is not weighed when unloaded. The dock is equipped with three storage bridges having 7½-ton clams, and one storage bridge having a 12-ton clam. It has a storage capacity of 1,500,000 tons.

Dock: Lehigh Valley R. R. Co.

Operating Company: Lehigh Valley R. R. Co.

Manager: C. T. O'Neal.

Superintendent: C. I. Heckman.

Description: The dock is equipped with six steam power Brown hoists and four steam power McMyler whirlers having 1-ton hand-filled and 3-ton automatic buckets, respectively. The Brown hoists and two of the McMylers are operated single shift, and two of the McMylers double shift. The unloading capacity is 9,700 tons per 20-hour day, and the storage capacity is 200,000 tons. The ore is weighed by the railroad company on railroad scales.

Dock: Pennsylvania R. R. Co.

Operating Company: Pennsylvania R. R. Co.

Superintendent: Geo. Berg.

Description: The dock is equipped with one electric Hulett and two Brown electric unloading machines having 10 and 5-ton automatic buckets, respectively. It is operated single shift and has an unloading capacity of 7,000 tons per 10-hour day. The ore is weighed on railroad scales, and the dock has a storage capacity of 200,000 tons.

Dock: Rogers-Brown Iron Co.

Operating Company: Rogers-Brown Iron Co.

Manager: Hugh Kennedy.

Description: The dock is equipped with five Brown electric unloading machines with 5-ton automatic buckets, and has an

unloading capacity of 15,000 tons per 20-hour day.

Dock: West Shore.

Operating Company: Ashtabula & Buffalo Dock Co.

Manager: H. S. Pickands. Superintendent: W. E. Chilson.

Description: The dock is equipped with three Brown electric unloading machines with 5-ton automatic buckets. It is operated single shift, and has an unloading capacity of 7,500 tons per 10-hour day, and a storage capacity of 75,000 tons. The ore is weighed by railroad scales.

Dock: Wickwire Steel Co.

Operating Company: Wickwire Steel Co.

Superintendent: J. W. Lockie.

Description: The dock is equipped with one electric Hulett with 10-ton automatic bucket, and is operated double shift. It has an unloading capacity of 8,000 tons per 20-hour day, and a storage capacity of 700,000 tons. It has one storage bridge with 7½-ton clam.

Dock: Tonawanda Iron & Steel Co.

Operating Company: Tonawanda Iron & Steel Co.

Description: The dock is equipped with four steam power Brown bridges with 1-ton hand-filled buckets. It is operated double shift, and has an unloading capacity of 2,400 tons per 20-hour day, and a storage capacity of 240,000 tons.

CLEVELAND.

Dock: Central Furnace.

Operating Company: American Steel & Wire Co.

Superintendent: Q. A. Gillmore.

Description: The dock is equipped with four Hoover & Mason, four King, and two Hulett unloading machines, all electric controlled with 7½-ton, 2-ton and 10-ton automatic buckets, respectively. It is operated single shift, and has an unloading capacity of 12,000 tons per 10-hour day. The ore is weighed on railroad scales. The dock is equipped with one storage bridge with 10-ton clam and has a storage capacity of 750,000 tons.

Dock: Cleveland Furnace Co.

Operating Company: Cleveland Furnace Co.

Superintendent: G. B. Blackmer.

Description: The dock is equipped with two steam McMyler and two steam Brown re-built unloading machines with 2-ton and 5-ton automatic buckets, respectively. The McMyler machines are operated single shift, and have an unloading capacity of 2,000 tons per 10-hour day. The Brown machines are operated double shift, and have a capacity of 5,000 tons per 20-hour day. The ore is weighed by railroad scales. The dock is equipped with one storage bridge with 15-ton bucket, and has a storage capacity of 500,000 tons.

Dock: Mahoning St.

Operating Company: Cleveland Furnace Co.

Superintendent: G. B. Blackmer.

Description: The dock is equipped with two McMyler steam whirlers with 2-ton automatic buckets, and is operated single shift. It has an unloading capacity of 2,000 tons per 10-hour day, and has no storage capacity. The ore is weighed by railroad scales.

Dock: Cleveland & Pittsburgh.

Operating Company: Ohio & Western Pa. Dock Co.

Superintendent: C. E. Cole.

Description: The dock is equipped with four electric Hulett's, six steam Hoover & Mason, 12 steam Brown unloading machines, with 17-ton, 5-ton and 1½-ton automatic buckets, respectively. The Hulett machines are operated double shift and have an unloading capacity of 40,000 tons per 20-hour day. The Hoover & Mason and the Brown machines are operated single shift, and have unloading capacities of 7,000 and 6,000 tons, respectively, per 10-hour day. The ore unloaded by the Hulett and Hoover & Mason machines is weighed by machine hopper scales, and the ore unloaded by the Brown machines, by railroad scales. The dock is equipped with one storage bridge with a 20-ton clam, which receives ore unloaded by the Hulett machines. The storage capacity under this bridge is 750,000 tons.

Dock: Erie.

Operating Company: Erie Dock Co.

Manager: H. S. Pickands. Superintendent: W. T. Moore.

Description: The dock is equipped with four Brown electric, and four Hoover & Mason steam power unloading machines, each

with 5-ton automatic buckets. The Brown machines are operated double shift and have an unloading capacity of 20,000 tons per 20-hour day. The Hoover & Mason machines are operated single shift, and have an unloading capacity of 6,000 tons per 10-hour day. The ore unloaded by the Brown machines is weighed by machine hopper scales, and the ore unloaded by the Hoover & Mason machines, by machine track scales. The stockyard is at Randall and is equipped with one storage bridge with a 10-ton clam. The storage capacity is 1,000,000 tons.

Dock: River.

Operating Company: The River Dock Co.

Superintendent: W. H. Everhart.

Description: The dock is equipped with three electric Hulett unloading machines with 10-ton automatic buckets, and is operated single shift. It has an unloading capacity of 12,000 tons per 10-hour day. The ore is weighed by railroad scales. The dock is equipped with two storage bridges with 10-ton clams and has a storage capacity of 1,000,000 tons.

Dock: The Upson Nut Co.

Operating Company: The Upson Nut Co.

Manager: Willard Fuller. Superintendent: H. J. Allen.

Description: The dock is equipped with one Wellman-Seaver-Morgan electric bridge with 5-ton automatic bucket, and is operated double shift. It has an unloading capacity of 4,000 tons per 20-hour day, and a storage capacity of 150,000 tons. The ore is weighed by railroad scales.

CONNEAUT.

Dock: Pittsburgh & Conneaut.

Operating Company: Pittsburgh & Conneaut Dock Co.

Superintendent: Clarence Walker.

Description: Dock No. 1 is equipped with nine steam conveyors with 1-ton hand-filled buckets, operated single shift with an unloading capacity of 2,500 tons per 10-hour day; and four steam conveyors with 2-ton automatic buckets, operated double shift with an unloading capacity of 1,800 tons per 20-hour day. It has a storage capacity of 440,000 tons.

Dock No. 2 is equipped with 12 McMyler electric unloading machines with 2-ton automatic buckets, and is operated double shift. It has an unloading capacity of 10,000 tons per 20-

hour day.

Dock No. 3 is equipped with five steam whirlers with 1-ton hand-filled buckets, and is operated single shift. It has an

unloading capacity of 2,700 tons per 10-hour day.

Dock No. 4 is equipped with four Brown electric and four steam and one electric Hulett machine with 5-ton, 10-ton, and 15-ton automatic buckets, respectively. It is operated double shift, and has an unloading capacity of 33,500 tons per 20-hour day. The dock is equipped with two storage bridges with 7½ and 10-ton clams, and has a storage capacity of 1,000,000 tons.

The total storage capacity of the dock is 1,440,000 tons. The ore unloaded by the electric Hulett is weighed by machine hopper scales.

DETROIT.

Dock: Detroit Furnace Co.

Operating Company: Detroit Furnace Co.

Manager: G. C. Clutts.

Superintendent: W. W. Butler.

Description: The dock is equipped with two steam Brown unloading machines with 2-ton automatic buckets. It is operated single shift, and has an unloading capacity of 2,000 tons per 10-hour day. The storage capacity of the dock is 100,000 tons.

Dock: Detroit Iron & Steel Co.

Operating Company: Detroit Iron & Steel Co.

Superintendent: P. J. Moran.

Description: The dock is equipped with two Wellman-Seaver-Morgan and one Brown bridge, electric controlled, with 5-ton automatic buckets. It is operated double shift, and has an unloading capacity of 4,000 tons per 10-hour day. The storage capacity is 200,000 tons.

ERIE.

Dock: Erie & Pittsburgh R. R.

Operating Company: Ohio & Western Pa. Dock Co.

Superintendent: D. K. Smith.

Description: Dock No. 1 is equipped with 12 steam power Brown bridges with 2-ton automatic buckets. It is operated single shift, and has an unloading capacity of 6,000 tons per 10-hour day. Dock No. 4 is equipped with 12 steam power Brown bridges with 1-ton hand-filled buckets. It is operated single shift, and has an unloading capacity of 2,200 tons per 10-hour day. Dock No. 1 has a storage capacity under machines of 120,000 tons, and Dock No. 4 has a storage capacity under machines of 360,000 tons. The ore is weighed by railroad scales.

Dock: Philadelphia & Erie R. R. Co.

Operating Company: James Thompson, Contractor.

Superintendent: R. M. Thompson.

Description: The dock is equipped with one electric Hulett and two steam McMyler machines with 10-ton and 2-ton automatic buckets, respectively. It is operated both single and double shift, and has an unloading capacity of 12,000 tons per 20hour day. It is equipped with three storage bridges with 1-ton clams, and has a storage capacity of 160,000 tons. The ore is weighed by railroad scales.

FAIRPORT.

Dock: Fairport.

Operating Company: Pennsylvania & Lake Erie Dock Co.

Manager: R. R. Richardson. Superintendent: G. S. Meek.

Description: The dock is equipped with six Brown electric unloading machines with 5-ton automatic buckets. Three machines are operated single, and three machines double shift. The unloading capacity is 25,000 tons per 20-hour day. The ore is weighed by railroad scales.

GARY.

Dock: Indiana Steel Co.

Operating Company: Indiana Steel Co.

Superintendent: W. P. Gleason.

Description: The dock is equipped with five electric Hulett unloading machines with 10-ton automatic buckets, and is operated double shift. It has an unloading capacity of 30,000 tons per 20-hour day. The ore is weighed by machine hopper The dock is equipped with five storage bridges with 14-ton clams, and has a storage capacity of 2,500,000 tons.

HURON.

Dock: Wheeling & Lake Erie R. R.

Operating Company: Wheeling & Lake Erie R. R. Co. Superintendent: T. R. Gillmore.

Description: Dock No. 2 is equipped with four steam Hulett and two steam and hydraulic Hulett unloading machines with 5 and 15-ton automatic buckets, respectively. It is operated single shift and has an unloading capacity of 10,000 tons per 10-hour day. It is equipped with one storage bridge with 12ton clam, and has a storage capacity of 500,000 tons. Ore weighed by railroad scales.

INDIANA HARBOR.

Dock: Inland Steel Co.

Operating Company: Inland Steel Co. Manager: P. D. Block.

Superintendent: J. W. Lees.

Description: The dock is equipped with two electric bridges with 6-ton automatic buckets, and is operated double shift. It has an unloading capacity of 9,000 tons per 20-hour day. The dock has a storage capacity of 600,000 tons.

LORAIN.

Dock: Baltimore & Ohio R. R. Co.

Operating Company: Baltimore & Ohio R. R. Co.

Terminal Agent: C. E. Pierce.

Description: The dock is equipped with three Brown electric unloading machines with 9½-ton automatic buckets, and is operated double shift. It has an unloading capacity of 20,000 tons per 20-hour day. The ore is weighed by railroad scales. The dock is equipped with one storage bridge with 10-ton clam, and has a storage capacity of 360,000 tons.

Dock: The National Tube Co.

Operating Company: The National Tube Co.

Manager: Max M. Suppe.

Description: The dock is equipped with four electric Hulett unloading machines with 8-ton automatic buckets, and is operated double shift. It has an unloading capacity of 32,000 tons per 20-hour day. The ore is weighed by railroad scales. The dock is equipped with two storage bridges with 12-ton clams and has a storage capacity of 1,900,000 tons.

MIDLAND.

Dock: Canada Iron Corporation.

Operating Company: Canada Iron Corporation.

Description: The dock is equipped with two steam McMyler machines with 5-ton automatic buckets, and has an unloading capacity of 1,200 tons per 10-hour day.

MILWAUKEE.

Dock: Illinois Steel Co.

Operating Company: Illinois Steel Co.

Description: The dock is equipped with ten steam Brodesser unloading machines with 1,800-pound hand-filled buckets, and is operated single shift, having an unloading capacity of 2,000 tons per 10-hour day.

Dock: Thomas Furnace Co.

Operating Company: Thomas Furnace Co.

Superintendent: Wm. J. Price.

Description: The dock is equipped with one electric bridge with 6½-ton automatic bucket, and is operated double shift. It has an unloading capacity of 4,500 tons per 20-hour day.

PORT COLBORNE, ONTARIO.

Dock: Canada Furnace Co., Ltd.

Operating Company: Canada Furnace Co., Ltd.

Manager: B. Marron, Buffalo, N. Y.

Superintendent: W. F. Burket, Port Colborne, Ont.

Description: The dock is equipped with two McMyler electric bridges having 6-ton automatic buckets, and has an unloading capacity of 8,000 tons per 20-hour day. It is operated both double and single shift, and all of the ore is stocked.

POINT EDWARD.

Dock: Point Edward.

Operating Company: The Steel Co. of Canada.

Manager: W. J. Constable.

Description: The dock is equipped with three steam McMyler and one steam Brown unloading machines with 4 and 2-ton automatic buckets, respectively, and is operated single shift. It has an unloading capacity of 5,000 tons per 10-hour day. The ore is weighed by railroad scales. The dock has no storage capacity.

SAULT STE. MARIE.

Dock: Algoma Steel Corporation, Ltd.

Operating Company: Algoma Steel Corporation, Ltd.

General Manager: Sam'l Hale.

General Superintendent: C. E. Duncan.

Description: The dock is now equipped with two Wellman-Seaver-Morgan electric bridges with 4-ton automatic buckets, and is operated double shift, having an unloading capacity of 5,000 tons per 20-hour day. In addition to the above equipment, a Brown electric bridge with 7½-ton automatic bucket is under construction for operation in 1914. The storage capacity of the dock is 400,000 tons.

SOUTH CHICAGO.

Dock: Federal Furnace Co.

Operating Company: Federal Furnace Co.

Manager: Geo. H. Beaumont. Superintendent: D. L. Ward.

Description: The dock is equipped with three electric Brown bridges with 5-ton automatic buckets, and is operated double shift, having an unloading capacity of 9,000 tons per 20-hour day. The ore is weighed by railroad scales. The storage capacity is 300,000 tons.

Dock: Illinois Steel Co., South Works. **Operating Company:** Illinois Steel Co.

Description: The north dock is equipped with 15 electric Hoover & Mason unloading machines with 5-ton automatic buckets, and is operated single shift, having an unloading capacity of 15,000 tons per 10-hour day. The dock is equipped with four storage bridges, two of them having 12-ton, and two of them 2-ton clams. The storage capacity is 1,750,000 tons.

The south dock is equipped with seven electric Hoover & Mason unloading machines, and is operated single shift, having an unloading capacity of 10,000 tons per 10-hour day. The ore is weighed by railroad scales. The dock is equipped with two storage bridges with 12-ton clams, and has a storage capacity of 850,000 tons.

Dock: Wisconsin Steel Co.

Operating Company: Wisconsin Steel Co.

Superintendent: G. E. Rose.

Description: The dock is equipped with three Brown electric unloading machines with 5-ton automatic buckets, and is operated double shift, having an unloading capacity of 14,000 tons per 20-hour day. The dock is equipped with two storage bridges with 7-ton clams, and has a storage capacity of 450,000 tons.

TOLEDO.

Dock: Cincinnati, Hamilton & Dayton R. R. Co.

Operating Company: Cincinnati, Hamilton & Dayton R. R. Co.

General Agent: R. B. Mann.

Description: The dock is equipped with two electric Hulett unloading machines with 15-ton automatic buckets, and is operated single shift, having an unloading capacity of 10,000 tons per 10-hour day. The ore is weighed by machine hopper scales, and by railroad scales. The storage capacity is 600,000 tons.

Dock: The Toledo Furnace Co.

Operating Company: The Toledo Furnace Co.

Manager: E. B. Hull.

Description: The dock is equipped with three Hoover & Mason electric unloading machines with 5-ton automatic buckets, and is operated single and double shift, having an unloading capacity of 18,000 tons per 20-hour day. The ore is weighed by railroad scales. The dock is equipped with one storage bridge with 10-ton clam and has a storage capacity of 500,000 tons.

Dock: The Toledo & Ohio Central R. R. Co.

Operating Company: The Toledo & Ohio Central R. R. Co.

Superintendent: C. A. Hoyt.

Description: The dock is equipped with three Brown electric unloading machines with 5-ton automatic buckets, and is operated single shift, having an unloading capacity of 5,000 tons per 10-hour day. The ore is weighed by railroad scales. The storage capacity is 80,000 tons.

Chapter VI.

CLASSIFICATION OF LAKE SUPERIOR ORES.

In the early days of iron ore mining, and up to within a comparatively few years, the ore from any one mine was fairly uniform in composition. As the production increased, however, and the field of available ore was broadened to include deposits previously regarded as unprofitable, it became necessary to grade ores according to their composition, and further to mix ores of a different composition to produce certain grades. At the present time it is quite common for one mine to ship several different grades and for the ore from several mines to be grouped under one name. These conditions brought about a necessity for knowing the exact composition of the various ores, and whether or not, in the case of a mixed ore, each cargo was of grade guaranteed.

The successful operation of a blast-furnace depends largely on keeping the conditions under which it is running, constant. The ore must be charged into the furnace with the proper proportions of limestone and coke, so that the impurities will properly flux and the desired grade of iron be produced. These proportions of fluxing materials and fuel vary with the composition of the ore. At the beginning of the year, the furnace-manager determines his requirements as to limestone and coke for the coming season, using the analyses, as guaranteed by the sellers of the ores, which he expects to use. In this manner the cost of the pig iron is determined. If the composition of the ore varies from the guaranteed analyses, it is apparent that the furnace-manager will be forced to make troublesome changes from his schedule. He will have to increase or decrease the amounts of coke or limestone in his charge, raise or lower the blast temperature, and finally he may not even be able to make the expected grade of pig-iron. Thus, it can be readily understood that a thorough knowledge of all phases of the variability or regularity of ore composition is of paramount importance to the consumer as well as the producer of iron ore.

The chemical reactions which take place within a blast furnace are complex, but the following is a brief description of the several steps in the reduction of iron ore: The oxygen of the air which is blown in at the tuyeres meets the glowing coke and forms carbonic acid gas (CO₂). This gas is at once reduced to carbon monoxide (CO) and is the active agent in the reduction of the ore. The ore, which is an oxide of iron, loses its oxygen to the carbon monoxide forming carbonic acid gas and metallic iron. The carbonic acid is again reduced by the incandescent coke and the resulting carbon monoxide reduces more ore. These reactions continue until finally the carbonic acid is carried out of

the top of the furnace together with some carbon monoxide and the nitrogen of the air. Unfortunately all the impurities do not stay in the slag. Practically all the phosphorus, quite a considerable amount of the sulphur, about three-quarters of the manganese, and more or less silicon, reduced from the silica, go into the iron. All the alumina, lime and magnesia of the ore stay in the slag. Lime and magnesia to a certain extent, are desirable constituents of iron ores, because in using such ores in a blast furnace, less limestone is required to form a slag. Alumina is not so desirable, the less sulphur the better, and the amount of phosphorus determines whether the ore is Bessemer or Non-Bessemer. Manganese within certain limits, is not harmful in an ore.

Strictly speaking, a Bessemer ore is one in which the phosphorus is low enough to make Bessemer iron, which latter is supposed to contain not over 0.100 per cent phosphorus. Hence, theoretically, the maximum allowable phosphorus in a Bessemer ore, depends on the iron contents. A common way of expressing this is, that the numerical figures of the dry phosphorus percentage must not exceed the numerical figures of the dry iron percentage, that is, if the dry iron in an ore is 55 per cent, the phosphorus should not exceed 0.055 per cent. The phosphorus in a Bessemer ore may vary widely but it is generally accepted in the trade that the maximum must not be over 0.060 per cent.

A Non-Bessemer ore is one whose phosphorus content is too high to make Bessemer iron.

All iron ore contains a certain amount of moisture as it comes from the ground. As the ore is unloaded at the furnace, this moisture will be more or less, than it was at the mine, depending on whether it has been subjected to wetting or drving conditions. Before the chemist determines the iron or any other constituent, the sample is dried at 100° C. which is the same as 212° F. This drying, of course, removes all the moisture from the ore, except that which is chemically combined. This is done in order to have the sample in a uniform physical state. If the ore was not dried two chemists working on the same sample, would probably not be able to get the same results. For instance, in determining iron they would not have the same amount of ore in the same weight taken by each, because of more or less moisture present. The furnaceman, however, is not so much interested in the "dry" analysis, since, when the ore is weighed into the furnace, it contains more or less moisture. This is the reason why analyses are reported in both the "dry" and "natural" conditions. The "natural" represents the iron in the ore, in the condition in which it was sampled. This "natural" analysis, of course, is a calculated one. For instance, the dry analysis shows the iron to be 60 per cent, and the moisture 10 per cent; substracting the percentage of moisture from 100 per cent, and multiplying the remainder by

the "dry" iron, we have 54 per cent, which is the "natural" iron in the ore. The same method of procedure gives the natural analysis of the other constituents of the ore, and in calculating a burden for a blast furnace, the "natural" analysis is used.

SAMPLING LAKE SUPERIOR IRON ORES.

In the early days of the iron ore industry, the question of sampling received but scant attention. Samples of ore were shown, and assurances given that shipments would be uniform and of a certain composition. There were but comparatively few ores on the market, these were well known and were high in iron. As the demand for ore increased, more ore was produced, and it became necessary for the seller to guarantee the iron content, determined in the ore dried at 212° F. At times it was found somewhat difficult to keep the ore up to this guarantee, and it became a custom to divide the selling price by the guarantee, thus establishing a unit value. Averaging the analyses of the buyer and seller, and multiplying by the unit value, gave the selling price of the ore.

After the soft ores came onto the market, the question of moisture became of great importance, and a readjustment of the guarantee became necessary, changing the basis from the dry to the natural condition. For many years the value of ores was arrived at by adding an average freight rate to the furnace, to the price quoted at lower lake ports, and dividing this sum by the guaranteed percentage of natural iron. This gave a base unit value which, multiplied by the percentage of natural iron, gave the selling price of the ore. In 1908 a new method of figuring the value of an ore was adopted by most of the sellers. This method is described elsewhere in this book.

There is probably nothing in connection with the handling of iron ore which has been the subject of more disputes than the question of sampling. Much has been written about the matter, and it has been clearly demonstrated that the subject is an extremely complicated one, and one in which higher mathematics play an important part. The sampling of the ore, however, must necessarily be done by a class of men not familiar with higher mathematics, and as a rule, not capable at all times of exercising proper judgment as to the correct proportions of lump and fine, wet and dry ore.

Since the calculation of a blast furnace burden is dependent on the analysis of the material to be used in the furnace, it is of great importance that the sample of ore be as near correct as possible. Analytical work has been standardized until at present the various constituents of iron ore can be determined accurately, at least within very narrow limits of error. If the sample is not correctly taken, the chemical analysis, however accurate it may be, is of no practical value. It is necessary and of greatest importance, therefore, that methods of sampling should be so standardized that a truly representative sample may be taken in every case. This has been done at the lower lake ports, is being agitated at the furnaces, and is being brought about at the mines. We do a large amount of this work, and have given the matter very careful consideration. It is our opinion that the judgment of the sampler should be depended upon as little as possible; in other words, the nearer we can approach a mechanical sample, the more liable are we to obtain a correct average of the ore.

On account of the varying conditions at the different mines, it is probably impossible to determine upon any one method of sampling which would apply at all times and in all cases. However, it would seem as though some general principles might be suggested which would tend to overcome the difficulty of getting a representative sample of ore. A number of the mines have appreciated the importance of this factor in the iron ore trade, and have adopted standardized methods of sampling, but many of the mines are as yet paying but little attention to sampling from a scientific standpoint.

In 1907, the Cleveland chemists adopted a standard method of sampling which was a step in the right direction. This method has been improved from year to year, and while it is not perfect, it has shown itself capable of giving accurate results if conscien-

ciously carried out.

It is at the various furnace plants where Lake Superior ores are used that we find the widest variations in methods of sampling, and yet the results of these samplings are compared with the samples of the cargoes taken at the lower lake ports, where four or more men have sampled, perhaps for 12 or 18 hours, by the standard method. It is needless to say that in a great many cases, discrepancies occur between the analyses of the two sets of samples.

Following is the standard methods of sampling adopted by the Cleveland chemists. This method is used by all the independent chemists of Cleveland in sampling ore at the lower lake

ports.

STANDARD METHOD FOR SAMPLING CARGOES OF IRON ORE AT THE LOWER LAKE PORTS.

A standard sample shall be taken from all cargoes, the weight of the sample varying with the size of the cargo. The sample shall be taken with an iron scoop 3½ inches long, 2½ inches wide, and 1½ inches deep, the handle 6¾ inches long; and with a hammer 12 inches long (the scoop holds approximately ½ pound).

It shall be the aim to take an equal bulk of ore from every point selected. When a lump is encountered, a portion shall be broken off equal in bulk to a scoopful of soft ore. In sampling cargoes no sample shall be taken from the original outside surface on account of the presence of foreign matter and an undue proportion of fines.

If the surface to be sampled has been exposed to rain or sun long enough to materially alter the amount of moisture present, the sample shall be taken about three inches below the surface.

In order to keep the size of samples within reasonable bounds and to gauge the size to the size of the boat, the sampler shall on cargoes up to 3,500 tons, begin sampling at a convenient point, at the bottom of the face of the ore and shall take one standard scoopful every two scoop lengths up the face of the ore to the top, and then shall move four scoop lengths to one side of the starting point before again sampling vertically. He shall continue in this manner keeping the above distances around the face of the ore to the place of beginning.

On cargoes from 3,500 to 6,000 tons, he shall use the two scoop lengths for vertical distances up the face of the ore, but move six scoop lengths horizontally.

On cargoes over 6,000 tons, he shall use the two scoop lengths for vertical distances up the face of the ore, but move eight scoop lengths horizontally.

In cases of split cargoes, horizontal spacing to be according to the tonnage of each individual ore as specified in the preceding paragraphs.

At convenient stages of unloading, the sample shall be mixed and quartered. This must be done each time exactly alike, by breaking down to one-half inch, mixing and quartering twice, thus preserving the proper proportion of the whole sample.

If in the final quartering, the last two quarters exceed a can full, the ore shall be quartered again and one quarter rejected.

The sample may be quartered on the vessel, or may be taken to some other place suitable for the purpose. Samples must be shipped in standard cans.

Sampling Soft Ore.—The sampler shall enter any hatch and begin sampling when the unloading machines have exposed five or six feet of the face.

The sampler shall then enter the next hatch working, and proceed to sample in the same way, and so continue in every working hatch.

The sampler shall then begin over again in the hatch in which he first started and continue the sampling in all the working hatches, provided there has been sufficient ore removed in such hatches since the faces were sampled to expose fresh ore. The sampler shall continue this method of sampling in each hatch worked, until there is less than one-tenth of the ore left.

In sampling horizontal surfaces, as in boats where scrapers are used, the sampler shall sample every two scoop lengths lengthwise of the boat, the spaces between the lines of sampling to be 4-6-8 scoop lengths according to the tonnage as described before.

Sampling of Hard Ore—In sampling hard lump ore the sampler shall begin sampling, and use the same spacing as defined for soft ore, using hammer lengths, instead of scoop lengths. At each point sampled he shall take lump or fine ore equal to one cubic inch. In taking this cubic inch the sampler shall take an average from the lump ore from which the cubic inch is broken.

Moisture Sample.—The moisture sample shall be taken from

the standard sample in the following manner:

When as many cans of ore have been filled as the stage of unloading will permit, the lump ore shall be broken up quickly and the entire amount thoroughly mixed and flattened out into a circular pile. The pile shall then be marked into quarters and one of the quarters divided into two parts by a radial line from the center to the outside of the pile. The whole of one of the half quarters so marked off is to be placed at once in a tightly covered receptacle to be a portion of the moisture sample. The other half of the quarter together with the opposite quarter are to be rejected.

The remainder of the pile is to be thoroughly mixed and flattened, and two opposite quarters rejected. The remainder of the ore is to be put one side for a portion of the standard sample.

By this method of procedure, one-eighth of the entire sample taken will go into the moisture sample.

At the end of the sampling the accumulated moisture sample is to be taken out of the tightly covered receptacle, quickly mixed and flattened out, divided into eighths and enough eighths taken to fill the standard moisture can.

In case of hard ores or small tonnages of soft ore, the proportion set aside for the moisture sample shall be increased so that at least one can of ore shall remain for the final moisture sample.

The moisture determination is made by drying the whole of the final moisture sample at a temperature not over 212° F. until there is no loss in weight. The loss of weight divided by the amount of ore taken, will give the percentage of moisture.

SUGGESTED METHODS OF SAMPLING AT THE MINES AND FURNACES.

Mine Sampling.—The sample should be taken from railroad cars after the cars are loaded, as follows: Begin at one end of a

car in the center, measure two hammer lengths along center line parallel to sides. At this point take a scoopful, if fine ore, or an equal bulk if lump ore. Measure the same distances and take same quantities in the same way until the other end of car is reached. Then repeat the operation on a line one-half way from center line and side, and then repeat again on line one-half way from center line and other side. For ordinary ores have hammer of such length that this proceeding will take ore from five points in each line, or fifteen points per car. For difficult ores, shorten the length of the hammer so as to touch eight or ten points in each line, giving twenty-four or thirty points to each car.

These car samples may be analyzed separately, or bunched in groups of five or ten for analysis. Using these car samples as units, the cargo analysis can then be calculated from the cars going into the cargo.

Furnace Sampling.—Ore as received at the furnace plants in cars, has been loaded by grab bucket in nearly all cases. This method of loading, itself tends to mix the ore so that a proper sample from the surface is fairly representative of the whole car.

Car Sampling.—Starting at a point one foot from the end of the car, move in a straight line lengthwise through the middle of the car over the piles of ore, taking equal bulks of ore every three feet. Measure these distances, and at the designated point dig about four inches below the surface and take a measured bulk of either lump or fine, whichever is encountered. A scoop holding about 0.5 pound of ore could be used, with a handle about 12 inches long, and the scoop may be used for measuring the distances. Or a measuring stick of the right length could be used, without inconvenience to the sampler. This method of sampling could be elaborated, if thought necessary, by going across the car twice more on lines about two-thirds the distance from the center of the car to the side of the car. This, of course, touches the ore in three times as many places, and in the case of mixed ore would tend to give a more representative sample.

VALUE OF LAKE SUPERIOR IRON ORES.

In a booklet called "Exhibit of the Condition and Prospects of the Lake Superior Iron Company" issued in March, 1853, occurs this paragraph: "The ore lies mostly above the surface; and for excellence is generally of a uniform character and is blasted out like rock in vast masses. The cost of mining it for years to come will not exceed ten cents per ton. At present prices, the ore is worth at Cleveland and Erie ten dollars per ton. Should its value at these places ever be reduced to five dollars per ton, which is not

at all probable, the business of the company even then would be highly profitable."

In 1856 the price dropped to \$8.00 and in 1860 to \$5.25 per ton, but it increased again and in 1873 was \$12.00 per ton for the Bessemer and \$9.00 per ton for the Non-Bessemer grades. The average prices for Marquette range ores from 1855 to 1877, the year that the first shipments of ore were made from the Menominee range, were \$7.93 per ton for the Bessemer and \$7.62 per ton for the Non-Bessemer grades. From 1877 to 1884, the year that first shipments were made from the Gogebic and Vermilion ranges, the average prices for Marquette and Menominee range ores were \$7.52 per ton for the Bessemer and \$5.62 per ton for the Non-Bessemer ores. In 1892 the Mesabi range commenced shipments and since that time it has been the dominating factor in the Lake Superior ore trade. It has provided an enormous tonnage of high grade ore that was easily accessible and while Mesabi range ore has been subject to a differential in price on account of its physical character, it has been so cheaply mined that its effect on the price of Old Range ores has been apparent. When shipments were first made from the Mesabi range, it was at a time of universal low prices, and in 1895 the prices of Mesabi range ores were \$2.15 per ton for the Bessemer and \$1.90 per ton for the Non-Bessemer grades, which are the lowest prices ever reached. Since that time the prices have increased, although there have been periods of depression and the average for the range up to and including 1914 has been \$3.51 per ton for the Bessemer and \$2.88 per ton for the Non-Bessemer grades.

The Lake Superior iron ores furnish approximately 80 per cent of the iron and steel requirements of the United States, and are tributary to that portion of the country that is most densely populated and that is best supplied with metallurgical fuel. They have been, and are, extremely valuable in the industrial development of the country.

On the following page will be found a table showing the prices of Old Range and Mesabi Bessemer and Non-Bessemer ores for each year since the opening of the ranges. It will be noted that until 1872 there was practically no difference in the prices of Bessemer and Non-Bessemer ores, although in some instances, Non-Bessemer sold for more than Bessemer. Since 1872 Bessemer ores have commanded a better price than Non-Bessemer ores, the difference varying from time to time.

PRICES OF IRON ORE AT THE LOWER LAKE PORTS SINCE THE OPENING OF THE RANGES. OLD RANGE MESABI.

	OLD	RANGE	MES.	ABI.
YEAR.	Bessemer.	Non-Bessemer.	Bessemer.	Non-Bessemer
1855	\$10.00	\$10.00		
1856	8.00	8.00		
1857	8.00	8.00		
1858	6.50	6.50		
1859	6.00	6.00		
1860	5.25	5.50		
1861	5.25	5.00		
1862	5.25	5.37		
1863	7.50	7.50		
1864	8.50	8.50		
1865	7.50	7.50		
1866	9.50	9.50 to 14.00		
1867	10.50	8.00 to 11.50		
1868	8.25	8.25		
1869	8.25	9.50		
1870	8.50	8.50 to 9.50		
1871	8.00	8.00		
1872	9.00	7.50		
1873	12.00	9.00		
1874	9.00 7.00	7.00		
1875	7.00 6.75	5.50 4.50		
1876		4.25		
1877	6.50			
1878	5.50 6.25	4.25		
1879		4.75		
1880	9.25	8.00		
1881	9.00	7.00		
1882	9.00	6.25		
1883	6.00 to 6.25	4.75 to 5.00		
1884	4.75 to 5.76	4.50		
1885	4.75 to 5.50	4.00 to 4.25		
1886	5.25 to 5.75	4.50 to 4.75		•
1887	6.00 to 7.25	5.00 to 5.25		
1888	4.75 to 5.75	4.00 to 4.75		
1889	4.50 to 5.50	4.50		
1890	5.50 to 6.75	5.25 to 5.75		
1891	4.50 to 6.00	4.00 to 4.75		
1892	4.50 to 5.65	3.65 to 4.85	** **	
1893	3.85 to 4.50	3.00 to 4.00	\$3.00	
1894	2.75 to 3.35	2.15 to 3.00	2.35	
1895	2.75 to 3.50	2.15 to 3.00	2.15	\$1.90
1896	3.50 to 4.00	2.25 to 2.85	3.50	2.25
1897	2.25 to 2.65	1.90 to 2.60	2.25	1.90
1898	2.25 to 3.35	1.75 to 2.45	2.25	1.75
1899	2.40 to 3.50	2.00 to 2.50	2.40	2.00
1900	4.50 to 6.48	4.00 to 5.00	4.50	4.00
1901	3.25 to 4.92	2.75 to 3.85	3.25	2.75
1902	3.25 to 5.00	2.75 to 4.00	3.25	2.75
1903	4.00 to 5.15	3.20 to 4.25	4.00	3.20
1904	3.00 to 3.85	2.50 to 3.35	3.00	2.50
1905	3.50 to 3.75	3.00 to 3.20	3.50	3.00
1906	4.00 to 4.25	3.50 to 3.70	4.00	3.50
1907	4.75 to 5.00	4.00 to 4.20	4.75	4.00
1908	4.50 to 5.00	3.70 to 4.20	4.75	4.00
1909	4.50	3.70	4.25	3.50
1910	5.00	4.20	4.75	4.00
1911	4.50	3.70	4.25	3.50
1912	3.75	3.05	3.50	2.85
1913	4.40	3.60	4.15	3.40 ⁻
1914	3.75	3.00	3.50	2.85

FIGURING THE PRICE OF LAKE SUPERIOR IRON ORES FROM ANALYSES.

For many years the value of standard Old Range and Mesabi iron ores has been arrived at by adding the freight rate to the Valley Furnaces, to the price quoted per ton at Lake Erie ports on base ores, either Old Range or Mesabi, and dividing this sum by the percentage of natural iron of such base ores. This gave a base unit value for figuring the price of all other standard Old Range or Mesabi ores. By multiplying the natural iron in any particular ore by the base unit value of either Old Range or Mesabi ores as the case may be, the selling price of such ore is obtained.

In the case of Bessemer ores, an addition or subtraction is made to provide for the percentage of phosphorus over or under the percentage of phosphorus in the base ore, as the case may be. At the present time and for several years, this deduction has been made according to a table of Phosphorus values which has been established.

In 1907 the percentage of the base ore, both Old Range and Mesabi, was reduced to more nearly conform to the average percentage of iron in the ores being brought down from the Upper Lakes. This change was thought to be fairer to the furnace interests than by using the base percentage which had been established some years earlier, when the average yield of all ores shipped from the Lake Superior region was higher. The present percentages in iron natural and phosphorus dry of the base ores are as follows:

- 1. Old Range Bessemer Ores, 55% iron natural and .045% phosphorus dried at 212° F.
 - 2. Old Range Non-Bessemer Ores, 51.50% iron natural.
- 3. Mesabi Bessemer Ores, 55% iron natural and .045% phosphorus dried at 212° F.
 - 4. Mesabi Non-Bessemer Ores, 51.50% iron natural.

To arrive at the base unit value, add 60 cents (an average freight rate to Valley Furnaces on ores shipped from Lake Erie ports) to the base price, and divide this sum by the base natural iron. Example:

Assuming the selling price of Class 1 ore is	\$3.7 5
Add average freight rate	
	\$4.35
Dividing this sum by the base natural iron, gives	0.07909
which is the base unit value.	

Assuming the selling prices of Classes 1, 2, 3 and 4 to be \$3.75, \$3.00, \$3.50 and \$2.85 per ton, respectively, and figuring the values as above; the base unit values are found to be:

For	Old Ra	nge Bessemer Ores	\$0.07909
		nge Non-Bessemer Ores	
		Bessemer Ores	
For	Mesabi	Non-Bessemer Ores	0.06699

These base unit values are used to determine the premiums or penalties to be added to or subtracted from the quoted selling prices of the base ores, in order to arrive at the actual value of the ores which may contain more or less than the guaranteed percentages of natural iron of the base ores.

To figure the value of Bessemer Ores, the following tables

are used:

For Ores Analyzing Under 55% Iron Natural:

From 55% to 50% Iron Natural, the value of each unit is the base unit. From 50% to 49% Iron Natural, the value is the base unit increased 50%. From 49% to 48% Iron Natural, the value is the base unit increased 100%. Less than 48% Iron Natural, the value of each unit is 16 cents, or whatever figure is named in the ore contract. For Ores Analyzing Above 55% Iron Natural:

From 55% to 56% Iron Natural, the value is the base unit increased 1 cent. From 56% to 57% Iron Natural, the value is the base unit increased 2 cents. From 57% to 58% Iron Natural, the value is the base unit increased 3 cents. From 58% to 59% Iron Natural, the value is the base unit increased 4 cents. From 59% to 60% Iron Natural, the value is the base unit increased 5 cents. Over 60% Iron Natural, the value of each unit is the base unit value, or whatever figure is named in the contract.

The Phosphorus adjustment is made according to the Phos-

phorus table a copy of which is herewith shown

pnorus table	e, a copy	of which is	nerewith sn	own.	
Percentage of	Rate of	Phos.	Percentage of	Rate of	Phos.
Phosphorus	Progression	Values	Phosphorus	Progression	Values
.070	.0200	.3500	.037	.0115	.0780
.069	.0195	.3300	.036	.0120	.0900
.068	.0190	.3105	.035	.0125	.1025
.067	.0185	.2915	.034	.0130	.1155
.066	.0180	.2730	.033	.0135	.1290
.065	.0175	.2550	.032	.0140	.1430
.064	.0170	.2375	.032	.0145	.1575
.063	.0165	.2205	.030	.0150	.1725
	.0160	.2040	.030		
.062				.0155	.1880
.061	.0155	.1880 .1725	.028	.0160	.2040
.060	.0150		.027	.0165	.2205
.059	.0145	.1575	.026	.0175	.2550
.058	.0140	.1430	.025	.0175	.2550
.057	.0135	.1290	.024	.0180	.2730
.056	.0130	.1155	.023	.0185	.2915
.055	.0125	.1025	.022	.0190	.3105
.054	.0120	.0900	.021	.0195	. 3300
.053	.0115	.0780	.020	.0200	. 3500
.052	.0110	.0665	.019	.0205	. 3705
.051	.0105	.0555	.018	.0210	. 3915
.050	.0100	. 0450	.017	.0215	.4130
.049	.0095	.0350	.016	.0220	. 4350
.048	.0090	.0255	.015	.0225	.4575
.047	.0085	.0165	.014	.0230	. 4805
.046	.0080	.0080	.013	.0235	. 5040
.045	.0000	.0000	.012	.0240	. 5280
.044	.0080	.0080	.011	.0245	. 5525
.043	.0085	.0165	.010	.0250	.5775
.042	.0090	.0255	.009	.0255	.6030
.041	.0095	.0350	.008	.0260	.6290
.040	.0100	.0450	.007	.0265	.6555
.039	.0105	.0555	.006	.0270	.6825
.038	.0110	.0665	.005	.0275	.7100
					.,,100

To figure the value of Non-Bessemer ores the following table is used:

Above 50% Iron Natural, the value is the base unit.

From 50% to 49% Iron Natural, the value is the base unit plus 50%.

From 49% to 48% Iron Natural, the value is the base unit plus 100%.

Less than 48% Iron Natural, the value of each unit is 14 cents, or whatever figure is named in the ore contract.

These calculations may be illustrated as follows:

Suppose the analysis of an Old Range Bessemer ore is 48% Iron Natural and .050 Phosphorus dried at 212° F., and that the base ore which is guaranteed to contain 55% Iron Natural and .045% Phosphorus dried at 212° F., is selling at \$3.75 per ton delivered at Lake Erie ports. The actual selling price would be calculated as follows:

From 55% to 50% equals 5 units. 5 times the base unit equals From 50% to 49% equals 1 unit. 1 times the base unit plus 50% equals	.\$.39545
From 49% to 48% equals 1 unit. 1 times the base unit plus 100% equals	
Penalty for Iron	.\$.67226 045
Total penalty Equals 72 cents per ton.	.\$.71726

This penalty subtracted from the base price of \$3.75 gives \$3.03 as the actual selling price of the ore.

Suppose the analysis of a Mesabi Bessemer ore is 57.50% Iron Natural and .043% Phosphorus dried at 212° F., and that the base ore which is guaranteed to contain 55% Iron Natural and .045% Phosphorus dried at 212° F. is selling at \$3.50 per ton.

The actual selling price would be calculated as follows:

•					
From 55% to From 56% to From 57% to	57% equa	ls 1 unit.	1 times base	unit plus 1c e unit plus 2c e plus 3c) equa	onals 09455
Premium Premium	for Iron for Phosph	orus (fro	m table)		\$.23138
Total Equal	Premium . Is 25 cents	er ton.	• • • • • • • • • • • • • • • • • • • •	• • • • • • • • • • • • • • • • • • • •	\$.24788

This premium added to the base price of \$3.50 gives \$3.75 as the actual selling price of the ore.

Suppose the analysis of an Old Range Non-Bessemer ore is 48% Iron Natural, and that the base ore which is guaranteed to contain 51.50% Iron Natural, is selling for \$3.00 per ton de-

livered at Lake Erie ports. The actual selling price would be calculated as follows:

From 51.50% to 50% equals 1½ units. 1½ times base unit equals\$.10 From 50% to 49% equals 1 unit. 1 times base unit)485
plus 50% equals)485
From 49% to 48% equals 1 unit. 1 times base unit plus 100% equals	
Total Penalty\$.34 Equals 35 cents per ton.	950

This penalty subtracted from the base price of \$3.00 per ton, gives \$2.65 as the actual selling price of the ore.

Suppose the analysis of a Mesabi Non-Bessemer ore is 55% Iron Natural and that the base ore which is guaranteed to contain 51.50% Iron Natural is selling for \$2.85 per ton delivered at Lake Erie ports. The actual selling price would be calculated as follows:

From 51.50% to 55% equals 3½ units. 3½ times base unit equals.....\$.23446 This will be the total premium, and equals 23 cents per ton.

This premium added to the base price of \$2.85 gives \$3.08 as the actual selling price of the ore.

In a manganiferous ore, up to four or five per cent, the manganese is usually calculated as a metal with the iron; that is, the total percentage of iron and manganese in the natural, are used as a percentage of iron in calculating the value of the ore. For ores with a higher percentage of manganese than four or five per cent, a special price is generally made.

Silicious ore, that is, ores 20 per cent or more silica, are generally sold for a special price.

Chapter VII.

BENEFICIATION OF ORES. The Concentration of Lake Superior Iron Ores.

The Lake Superior region, including shipments made during 1913, has produced 626,353,084 gross tons of iron ore. amount, 381,549,646 tons, or 60.9 per cent, has been produced in the last ten years; and 492,236,241 tons, or 78.6 per cent, in the last 15 years. During this period the average yearly production has increased rapidly, as shown by the following figures: From 1898 to 1902, inclusive, the total production of iron ore was 99,596,549 tons, or an average of 19,919,310 tons per year. From 1903 to 1907, inclusive, the total production was 161,395,657 tons, a yearly average of 32,279,131 tons, or an increase of 1.61 times that of the previous five-year period. From 1908 to 1913, inclusive, the total production was 216,991,058 tons, a yearly average of 43,398,211 tons, or an increase of 1.34 times that of the previous five-year period, and 2.18 times the average yearly production of the period from 1898 to 1902. The production in 1912 was 48,221,546 tons, and in 1913 was 49,947,116 tons. These figures show that the demand for Lake Superior ore has increased rapidly, and warrant the belief that the average vearly production will continue to increase for at least a few decades.

Another phase of the iron ore production from the Lake Superior region for the period under consideration is that the average iron contents in the ores produced has shown a slow but more or less steady decrease, owing to the gradual depletion of the higher grade ore deposits and the increasing use of lower grade ores. The average decrease in the iron contents for this period has been approximately one-third of a per cent per year, and the probability is that the quality of the ore will continue to slowly deteriorate, although enormous reserves of ore of lower grade may temporarily check this decrease. This condition has also tended to increase the tonnage of ore produced.

As a general proposition, buyers of Lake Superior ores demand ores of the highest quality available, and comparatively few ores of inferior grade have been shipped. Eventually these ores will have to be mined, and the problem of their treatment is becoming more important each year. If these ores are smelted in their natural condition, the cost of producing pig iron will increase, due not only to the fact that additional ore, coke and limestone will be required to produce a unit amount of pig iron, but also to increased operating and overhead charges at the furnaces. These factors are compensated for, to some extent by the lower price of ores of inferior grade, but it is probable that the

solution of the problem lies in the concentration of the lower grades of ore and the production of a high grade shipping product.

At the present time concentration has been adopted in only a few instances in the Lake Superior region, and it is probable that the present policy of taking the best of the ores available will be adhered to until operators are forced by necessity to resort to the lower grade ores. Recent estimates of the iron ore resources of the Lake Superior region show that the ores that are now of commercial grade will be exhausted in approximately 30 years, and that the great bulk of the iron ore resources of the region will average less than 45 per cent in iron. Concentration methods that will make this low grade ore available are sure to become of increasing importance. These methods may be classified as wet and magnetic concentration and calcination.

Wet concentration methods are now in use in the Lake Superior region on the Mesabi Range at the Trout Lake plant of the Oliver Iron Mining Co., near Coleraine; at the O'Brien Lake plant of the Wisconsin Steel Co., near Nashwauk; at the Madrid Mine near Virginia, and on the Marquette Range at the American Mine near Diorite.

The Trout Lake plant is located in what is known as the Canisteo district on the west end of the Mesabi Range, and receives ore from a number of mines operated by the Oliver Iron Mining Co. The ore is received at the mill in railroad cars operated over an enormous earth fill which is approximately 4,000 feet long, terminating in a steel trestle 650 feet long and having an elevation of 90 feet above the railroad tracks that are below the shipping bins. The ore is dumped from the cars into receiving bins and is handled in the mill entirely by gravity. The mill consists of five units, each unit being capable of independent operation. Each unit consists of a receiving bin having a capacity of 450 to 500 tons, from which the ore is sluiced by water jets over a bar grizzly into a revolving conical screen with 2-inch openings. The oversize from the screen is delivered to the shipping bin by a picking belt, and the undersize is treated in two 25-foot log-washers. The concentrates from the log-washers are discharged directly into the shipping bin and the tailings are de-watered and treated in two 18-foot "turbos," or small log-The concentrates from the turbos are discharged directly into the shipping bin and the tailings are de-watered and treated on 20 Overstrom tables. The concentrates from the tables are elevated by Frenier pumps to de-watering tanks and discharged directly into the shipping bin. The tailings from the mill are collected by launders in the mill basement and are discharged into Trout Lake by a concrete launder that is approximately 2,000 feet long. The plant was completed in 1910, and during each season since has operated continuously. Its capacity is approximately 3,000,000 tons of crude ore per season.

The Wisconsin Steel Co.'s plant at O'Brien Lake embodies the same principles as the Trout Lake plant, the distinctive features being in the method of handling the crude ore, and the absence of tables for treating the tailing from the small logwashers. Instead of having the long approach and steel trestle for delivering the crude ore to the receiving bins near the top of the mill, this plant receives the crude ore in a double bin located outside of the plant, and the ore is elevated to the top of the mill by a troughed belt conveyor which discharges directly onto a grizzly, doing away with the receiving bin at the top of the mill. This plant was completed in 1912 and has operated continuously during the shipping season since that time. It consists of one unit and has a capacity of approximately 4,000 tons of crude ore per day.

The Madrid Mine at Virginia, Minn., is a small underground property having a capacity of approximately 400 tons per day. The ore requires concentration to produce a commercial grade, both as to chemical analysis and physical structure. During 1912 attempts were made to concentrate this ore with a log-washer, but on account of the friable nature of the ore, this operation was not satisfactory. The problem of successfully concentrating this small tonnage of ore was solved by the installation of a Wetherbee Concentrator in the head-frame at the mine. machine is three feet in diameter and six feet high, and is installed just below a pocket which receives all of the material which passes through a one-half inch screen. The coarse ore does not require treatment, and goes directly to the shipping pocket. The concentrator discharges the concentrates, which have been de-watered by a perforated bucket elevator, into the same pocket which receives the coarse ore, and eliminates the fine silicious material from the ore. The machine was installed in the spring of 1913, and operated the balance of the season. The output is desirable, both as to structure and analysis.

On the other ranges only one plant is now in operation. This plant is that at the American Mine at Diorite on the Marquette Range. At this mine bodies of low grade ore occur at depth and are mined in connection with higher grade ore that is of merchantable quality without being concentrated. The low grade material requires crushing to unlock the ore from the gangue, and is closely sized by revolving screens preliminary to concentration. The products from the various screens are concentrated by Richards jigs, and the slimes by tables. The output is desirable both as to structure and analysis. The plant was completed late in 1912, and was operated continuously during 1913.

At the present time magnetic concentration is not used on any of the iron ranges on the American side of the Lake Superior region, although undoubtedly such concentration will eventually. be used on the eastern extension of the Mesabi Range, where enormous deposits of low grade magnetic ore are known to occur. This ore will require fine grinding, magnetic concentration, and briquetting to produce material suitable for furnace use. processes are now in use on the Canadian side, at the Moose Mountain Mine, Sellwood, Ontario, as described elsewhere in this book. In eastern Ontario, a magnetic concentration plant belonging to the Canada Iron Mines, Ltd., is in operation at Trenton. The mines shipping ore to this plant are located at Bessemer, Blairton, and Coe Hill. The ore is received on a trestle and is dropped into a storage bin. The entire feed to the mill is crushed to one-fourth inch and is sized by revolving screens which are flushed with water. The screenings are concentrated by Ball-Norton separators, and the slimes by a Grondal separator. The plant will consist of three units each having a capacity of 400 tons per day. One unit was completed in the summer of 1913 and approximately 23,000 tons of ore were produced during the balance of the season.

Another plant that is of interest in connection with processes for the beneficiation of Lake Superior ores is that at the Magpie Mine on the Michipicoten Range in Ontario. At this mine a low grade carbonate ore is treated in rotary kilns similar to those used in the cement industry. The carbon dioxide is expelled and the iron contents raised in the shipping product, while the sulphur is practically eliminated. Approximately 20,000 tons of ore were produced in 1913. The plant at this mine is now fully installed and it is expected that over 200,000 tons will be produced during 1914.

In addition to the plants described, several other plants are contemplated, or are under construction for operation during 1914, but descriptions of these plants are not now available. It is probable that other processes will be developed to meet other conditions and that concentration will occupy an increasingly important position in the Lake Superior region as the ore requirements increase and the available deposits of high grade ore are depleted.

THE DRYING OF LAKE SUPERIOR IRON ORES.

The moisture contents of Lake Superior ores fluctuate from 0.5 per cent in some of the hard ores to 17 or 18 per cent in some of the soft ores. The average, however, for the ores shipped during the season of 1913 was 11.60 per cent. In 1912 it was

11.15 per cent, and in 1911 it was 11.08 per cent. Considered by ranges, the average moisture contents for the season of 1913 were as follows:

Vermilion	5.78%
Menominee	7.86%
Marquette	10.04%
Gogebic	11.15%
Mesabi	12.50%

By grades the average moisture contents for 1913 were as follows:

Old Range Bessemer	9.60%
Old Range Non-Bessemer	9.10%
Mesabi Bessemer	
Mesabi Non-Bessemer	13.44%

The moisture in iron ore is important, as in most cases, iron ore is bought and sold on its metallic contents in the natural condition. If the moisture is excessive, it greatly affects the value of the ore. In sampling cargoes by the standard method at the lower lake ports great care is taken to obtain a moisture sample that is representative for the cargo. In sampling by this method, uniform amounts of ore are taken at regular intervals over freshly exposed surfaces of the ore as described elsewhere in this book, and as rapidly as the sample is accumulated, it is crushed, mixed and quartered, and one-eighth of it is placed in a large tightly covered storage can for the moisture determination, while the balance of the sample is again quartered and preserved for analysis. When the sampling has been completed, the portion of the sample that has accumulated in the storage can is mixed and quartered to a standard moisture can full for shipment to the laboratory. The sample is then dried at 212° F. and the loss in weight is reported as the moisture contents for that cargo. The standard sample is also dried at 212° F. and is crushed for The iron contents in the natural condition are then calculated from the dried analysis and the moisture determination and are so reported for that cargo.

A comparatively recent development in the iron ore production of the Lake Superior region is the installation of drying plants for treating ore with excessive moisture. The first experiments were made in 1911 on the Menominee Range at the Hollister Mine, but operations were discontinued, due to a lack of ore. In 1912 an experimental plant was installed at the Brunt Mine on the Mesabi Range, and it was demonstrated that ores with excessive moisture could be commercially dried. In 1913 a permanent plant was installed at the Brunt Mine, and was successfully operated the balance of the season. The plant consists of four cylindrical dryers, which are supported by steel

tires resting on bearing wheels, and are inclined so that the ore passes through them when they are rotated. The dryers are heated by independent furnaces, and require approximately two tons of coal per 100 tons of ore treated. The gases enter the dryers at approximately 1500° F. and pass out through an exhaust fan connected with a dust chamber at approximately 125° F.

The ore at the Brunt Mine contains approximately 17 or 18 per cent moisture, and it is reduced by drying to approximately 8 per cent. The mine is operated by open pit, and the ore is received at the drying plant on a short, high trestle. It is dumped directly on to a grizzly with manganese steel bars spaced five inches apart, and set at an angle with the slope. The ore that passes through the grizzly falls into a steel storage bin and the oversize is crushed in a gyratory crusher and is then delivered to the storage bin by a short belt conveyor. The ore is discharged from the storage bin by an automatic feeder and is delivered to the dryers by a belt conveyor. From the dryers it drops into a pivoted bucket elevator and is delivered into a steel storage bin from which it is drawn into cars as desired for shipment.

The advantages of drying ores that contain excessive moisture lie in the increased value given to the ore, the saving in freight per unit of iron, and in the increased facility with which the dried ore can be handled, as ores which have excessive moisture give more or less trouble in unloading from the cars and pockets at the docks, and are more liable to be frozen late in the season. The chief advantage, however, in drying ore with excessive moisture lies in the increased value given to the ore. This factor can be fairly closely calculated, for the dried ore does not readily take up moisture in transit or on the stock-pile. We have made numerous tests to determine this point, and have found that the dried ore, even when exposed on stock-pile all winter, does not change appreciably in moisture except on the surface where a crust is formed which protects the remainder of the pile from the elements. The saving in freight per unit of iron is also important. A similar plant is operating at the Whiteside Mine, and it is probable that additional plants will soon be built.

MILLING MOOSE MOUNTAIN IRON ORES.

Fred A. Jordan.

The ores of Moose Mountain are magnetites and of such low grade that they require concentration or beneficiating in the milling plants to bring them up to a marketable content. The deposits thus far known contain highly silicious non-Bessemer ores. These deposits vary within themselves, having rich ore on

one side, varying to lean ore on the other side. The deposits themselves differ from each other; some of the deposits being more of a banded silicious ore while others are less prominently banded by hornblende rather than silica and are higher in iron.

These different types of ore require different treatments. The banded silicious ore, which will be referred to as type No. 2, requires to be crushed and pulverized to 100 mesh, while the banded hornblende ore, which will be referred to as type No. 1, needs only to be crushed to one inch ring to make a marketable product.

Type No. 1 deposits differ from type No. 2 deposits also in that they have large inclusions of country rock within the deposit which is not the case with the type No. 2. Both types show a vertical continuity of surface structure and association. These deposits have been explored only to a depth of 300 feet.

The milling of type No. 1 ore is accomplished by first crushing in a jaw crusher, size 24 x 36, which takes about as large a piece of crude ore as can, with the mining methods in vogue, be brought to it, and delivers a product about four-inch cubes. This is not strictly true since the ore and rock break into slabby pieces. This four-inch product is then fed to a No. 4 gyratory crusher, that product screened in a revolving screen, which is designed to give a one-inch product. The oversize from the above screen is then fed to a 48-inch Symons disc crusher and its product screened in another screen similar to the above. oversize of this screen is fed to 42-inch rolls and again screened, its oversize being returned to the same rolls. The undersize after each operation is conveyed to a storage bin. It is thus seen that the crude ore from the mine goes through four stages of reduction and that the one-inch and under portion is screened out between each and the final stage of the last three reductions. All this is done preparatory to the magnetic separation.

The one-inch product from the screens is fed from the storage bin to a Ball & Norton single drum separator or cobber. This machine makes a very efficient separation of the ore from the rock. The current flowing to them can be varied and in this way a field of a certain magnetic intensity can be maintained such that the lean ore will not be attracted and will pass out with the waste rock, thereby allowing the concentrating of the ore up to a certain predetermined percentage of iron. The capacity of these separators is large and one will efficiently handle 60 gross tons per hour of crude ore crushed to a one-inch natural product.

The ore from these separators contains all of the dust resulting from the mining and the four stages of reduction. It is fed through a revolving screen of eight linear meshes per inch giving a resultant ore having not to exceed one-half of one per cent of material through a 20-mesh screen. This concentrating plant produces a physically ideal product under one inch and practically dustless, and is known as Moose Mountain cobbed ore. The dust is recovered and hauled to the plant for treating the No. 2 type of ores and is an ideal product for that plant to handle. The dust therefore is not a waste product, but simply a by-product, from the No. 1 mill, which is valuable in the No. 2 mill

The lean ore which is not attracted by the separator goes with the rock and is recovered by being passed over a second separator of higher magnetic intensity and in that way recovered and sent with the dust to the No. 2 plant.

The waste rock is disposed of for ballast and road material.

The treatment of the crude ore in the No. 1 mill does not raise the metallic content of the ore itself, but simply drops out the rock which comes included in the deposit, and it therefore only concentrates the crude ore. It does not reduce the phosphorus.

The type No. 2 ores may be defined as those ores which are too low in iron within themselves and which cannot therefore be treated in the No. 1 mill and which require fine grinding. These ores are very finely crystalline and it has been found that only when ground to a fineness of 100 mesh is it possible to separate the magnetite crystals from the gangue material. It is to treat these ores that the No. 2 plant and process are being developed. The process in its general features is that developed by Grondal The ore is pulverized to 100 mesh and separated in Sweden. from its gangue in a current of water by means of a Grondal Type V separator. The concentrates are de-watered and pressed Into briquettes. The briquettes as they leave the press contain from 7½ to 9 per cent of water. No binding material is used. The briquettes are loaded on to kiln cars and one car is pushed into the kiln every 20 minutes, at the same time pushing a car out at the discharge end. The kiln is 160 feet long and each car traveling intermittently is in the kiln 7½ hours. The drying of the briquettes, the agglomeration, the conversion into hematite, and the final giving up of a considerable amount of heat at the discharge end to the incoming air for combustion of the producer gas which is the fuel, is the cycle of changes taking place in the briquettes during their travel through the kiln. The Grondal process has been the subject of several papers in the technical societies and the reader is referred to them for a more detailed information. The ore from this plant is known as Moose Mountain briquettes. The Grondal process makes possible the utilization of deposits of magnetite as low as 35 per cent iron and efficiently concentrates these ores up to 64 per cent iron and a very low phosphorus content, and at the same time converting the magnetite to hematite. The mineral in these deposits which contains the phosphorus is non-magnetic and the phosphorus therefore goes with the gangue from the magnetic separator. The increase in the iron and decrease in the phosphorus are solely dependent on the fineness to which the crude ore is pulverized, since the separator works just as efficiently with slimes as it does with coarse material. Theoretically, the material should be ground so fine that each particle would be a free mineral crystal. The nearer that is accomplished the more perfect the separation up to a certain limit, measured by the efficiency of the separator.

THE AGGLOMERATION OF FINE IRON ORES. N. V. Hansell.

It has been repeated so often that it begins to be somewhat trite, that the high-grade lake ores will soon be exhausted and resort will have to be taken to the low-grade ores now discarded. Still, it is a fact, accentuated by the installation during the last few years of several washing plants for the sandy hematites on the Western Mesabi Range, the Grondal plant in Moose Mountain, Canada, etc.

In connection with the improvement of low-grade ores which have to be ground fine before they can be separated, the question of converting the fine concentrates by agglomeration into a form acceptable to the blast-furnaces becomes one of paramount interest. A number of different systems have been brought forth and are now being used commercially at various plants in the country for the agglomeration of iron bearing materials such as flue dust, pyrites residue, magnetic concentrates, Cuban brown ores, etc.

The agglomerated product as a rule has been found a very beneficial addition to a standard furnace burden. The reason for this is to be found chiefly in the porosity of the agglomerated material, which makes it easily reduced by the ascending gases in the furnace stack, and also in many cases, in its generally higher iron content, its low sulphur and phosphorus content, and its freedom from moisture. In the cost of pig iron, enter pre-eminently the cost of the raw materials at the furnace, the labor, upkeep and general expenses. The use of a relatively small percentage of sinter or briquettes in the burden will tend to lower the coke consumption per ton of pig iron; which in its turn will cause a reduction in the limestone requirements. The yield will be increased, while the labor cost, upkeep, and general expenses will be lowered. The physical condition of the sinter helps to keep

the furnace burden open, which steadies the furnace operations and insures a uniform quality of pig iron. Everything taken together will so distinctly improve the economical operations of the furnaces that the additional cost of producing the sinter will be offset. Its higher value will be recognized, and the agglomeration of fine iron ores or fine concentrates will be considered as one of the essential steps in the manufacture of iron.

Few figures are yet available in this country giving in dollars and cents the enhanced value of the sinter, but during the last year there has been enough published both here and abroad to cause the most skeptical iron-master to acknowledge his interest in the subject, and to look forward to receiving additional data from those who are going ahead in the establishment of agglomerating plants and those who are using the agglomerated

product in their furnace operations.

In this country the large quantities of blast furnace flue dust and pyrites residue that are being produced as waste products in the manufacture of iron and in the chemical industry have been given the first attention. The methods of agglomeration which have been worked out for them can in most cases be applied directly for the agglomeration of fine natural iron ore and concentrates.

These methods at present in commercial use on this continent can be classified as follows, the classification being more according to form of the finished product than based on the chemical changes that may have taken place in the agglomeration:

Briquetting:

- (a) By pressing and heating, employing no binder. (Grondal).
- (b) By the employment of a catalytic re-agent in the briquetting of fresh hot flue dust. (Schumacher).
- 2. Nodulizing in revolving furnaces.
- 3. Blast roasting by heating, chiefly by the combustion of fuel which has been intimately mixed with the ore.
 - (a) Up-draft blast roasting. (Huntington-Heberlein).
 - (b) Down-draft blast roasting.
 Continuous process. (Dwight-Lloyd).
 Intermittent process. (Greenawalt).

The Grondal Briquetting Process.—The Grondal furnace, briefly described, is a channel furnace through which the ore, compressed into briquette form, is conveyed on flat cars which constitute a continuous movable platform. The heat is obtained by the burning of gas, and any fuel containing sufficient calorific value may be used, the construction of the furnace necessarily being altered to suit the

fuel although the general design is governed broadly by the same principles. The briquettes are heated gradually by passing through zones of continually increasing temperature, the highest being about 2,500° F. After this heat, the briquettes are passed into a cooling chamber.

If a Grondal furnace is efficiently operated, strong, firm, briquettes of a dark color are produced. The atmosphere in the hottest part of the furnace is strongly oxidizing, and briquettes made of magnetic ore usually show more than 90 per cent of Fe₂O₃.

As the briquettes remain for several hours in this strongly oxidizing atmosphere, they are almost completely de-sulphurized, should sulphur be present. The product is particularly well suited for fixing purposes in open hearth furnace work.

The Schumacher Process.—This process consists in mixing with the flue dust a small amount of liquid containing some such material as magnesium or calcium chloride in solution, then thoroughly mixing the flue dust so as to produce as homogeneous a mass as possible. The mixture is then passed through a briquetting press where it is subjected to a pressure of about 6,800 pounds per square inch. The claim is that the liquid which is added to the flue dust produces a catalytic action on the elements of the flue dust, causing the briquettes to harden with age so that they may be charged into a blast furnace without disintegrating.

The Nodulizing Process.—This process for the treatment of finely granulated iron ore was the first one that proved commercially successful in the United States. The furnace used is of the type used for the production of cement clinker in the cement industry. Essentially it is a slowly rotating, slightly inclined, cylindrical kiln, into the upper end of which the fine ore is fed continuously by a mechan-The rotary motion of the kiln causes the ore to ical feeder. slide or roll, gradually, toward the lower end of the kiln, where it meets the highest temperature. The burning gases are introduced at the lower end of the kiln, and pass out at the upper, or The ore is thus gradually rolled from the lowest to feed end. the highest temperature of the kiln. Toward the lower end of the kiln, the ore particles become plastic, and agglutinate, and owing to the rotary motion of the kiln, become agglomerated into small balls or nodules which are discharged from the kiln in a red-hot condition. The fuel most commonly used to produce the heat is powdered coal, which is blown into the kiln by an air-blast; although almost any kind of fuel may be used that can be introduced by means of a central burner.

It will be understood from the description that the greater part of the kiln serves for pre-heating and de-sulphurizing purposes, and that the temperature of the ore is gradually raised to the point where it will sinter or agglomerate.

Sintering by Internal Combustion—Blast Roasting.—Recently a method of agglomerating fine ores by the internal combustion of intermixed coal, or of the sulphur in the contained sulphides, has gained prominence. At the present time there are three modifications of the method; the Huntington-Heberlein, using up-draft, the Dwight-Lloyd and the Greenawalt, using downdraft. The last two named have much in common, and at first glance, it would seem that the chief difference lies in the fact that one is continuous while the other is intermittent in operation. The Huntington-Heberlein process has a limited use in this country for the roasting and agglomeration of pyrite residues.

The Dwight-Lloyd Process.—By this process the fine ores and the crushed coal are fed in predetermined proportions into a pugmill, where they are thoroughly mixed and moistened with water. The mixed mass is conveyed directly to the sintering machine, which consists of an endless train of small cast pallets which are pushed along the track on the top of a suction or wind box. The bottom of the pallets is constructed of grates upon which the charge is fed to the thickness of five or six inches. The charge is ignited by an oil burner placed across the top of the pallets at the charging end of the machine. The speed of the pallets is so arranged that the temperature requisite for agglomeration has reached the grates by the time the pallets pass the farther end of the wind box. At the discharging end of the machine, a few feet beyond the end of the wind box, the pallets drop one by one a short distance through semi-circular guides, each pallet striking the preceding one a sharp blow. The blow loosens the sintered material from the grate, discharging it into a spout. The empty pallets return on the endless way, upside-down, to the charging end of the machine, where they receive another charge and again complete the cycle.

The Greenawalt Process.—The chief feature of this process is a shallow pan or converter of cast iron or cast steel, which is suspended by hollow trunions. A grate which is parallel with the bottom of the pan, divides it into two chambers, the lower of which is connected with a specially designed exhaust fan communicating with the chamber through the hollow trunions. The height of the upper chamber is regulated by the thickness of the layer of ore to be sintered, and this of course, is determined experimentally for each ore before treatment. In common practice, 12 inches is the distance from the grate to the upper edge of

the pan. The other dimensions of the pan depend on the tonnage desired. A size of 7 feet by 12 feet is considered as standard. For starting or igniting the charge a co-called "igniter" is used. This igniter is a perforated hood suspended by a system of levers that is carried on a double truck which runs on rails placed on the charging floor. It is provided with oil or gas burners which enter through the top or sides. By this system of levers, the igniter can be lowered on the top of the pan and made practically airtight.

The operation is as follows: A layer of green ore or fines from a previous charge is first placed on the grates. This layer serves to keep the fine ore of the charge from being drawn into the fan by suction, and is also a protection for the grate bars. It is called the "porous bed." The ore, mixed with coal and water in the right proportions, is next spread evenly over the surface of the bed. This is usually accomplished with a charging car or larry, which charges the ore into the pan and levels it, giving a uniform and evenly distributed charge without undue packing. The igniter is then put in position over the pan and the exhaust fan started. The mixture of oil and air is blown in under pressure through the oil burners and lighted. The flames fill the entire space between the cover and the charge and are drawn into the ore bed by suction. The surface of the ore bed soon appears to be glowing as the coal in it has ignited. When this point is reached, the oil is turned off and the igniter can be removed. Soon after the surface of the ore becomes blue and cold; the combustion in the charge is proceeding downwards in horizontal layers, and each thin layer is brought in turn to intense heat which causes the ore particles to agglutinate. In half an hour to an hour, depending upon the character of the ore, the combustion has passed through the charge and reached the porous bed. The heat then is sufficiently high to cause this bed to agglomerate with the rest of the charge, but the temperature drops so quickly that when the furnace is discharged the grates are found to be cold and black.

Chapter VIII. METHODS OF ANALYSES.

Preparation of the Sample.

The Standard Sample as received at the laboratory is thoroughly dried and put through a Gates Crusher, until the whole sample will pass a ¼-inch sieve. The sample is then thoroughly mixed and quartered through a Braun Quartering Machine three times. The final quartering is put through steel rolls until it will all pass a 20-mesh sieve. This entire sample is then mixed and quartered once through the Braun machine. One-half of the sample is thoroughly mixed and spread out on glazed paper. With a steel spatula, two three-ounce tin boxes are filled by dipping the ore from a number of places. These two boxes of ore are then thoroughly mixed and divided into two equal portions, one part is put through a 100-mesh sieve and is used for analysis, the other part is retained in a box for check determinations.

Moisture.

The ore samples are received from the boats in tightly covered tin cans. The sample for analysis weighs about thirty-five pounds, and that for moisture about twenty pounds. The entire moisture sample is emptied out into a shallow pan 24 x 18 x 2 inches. The pan is first weighed and then the pan and wet ore are weighed together. The pan of ore is placed on an enclosed steam coil and subjected to 212° F. heat for about twelve hours or until the weight is constant. The pan and ore are then weighed, and from the loss in weight, the percentage of moisture is calculated.

The sample for analysis is treated in the same way, and the moisture calculated. This is for an approximate check on the actual moisture determination.

Before analysis, the entire sample is dried for one hour at 100° C., removed from the oven and kept in a dessicator.

IRON. Weigh one-half gram of the ore into a 150 c. c. beaker, add 10 c. c. of a mixture (concentrated hydrochloric acid 3 parts, and stannous chloride 1 part), cover with a watch glass and heat slowly to boiling on a hot plate, agitating the solution. After boiling for one minute, the beaker is removed to a warm place on the hot plate and left standing until the solution is complete. When the residue in the beaker appears perfectly white, reduce with stannous chloride from a burette, until the solution becomes colorless; add three drops excess. Add 15 c. c. mercuric chloride solution and wash the contents of the beaker into a titration jar containing 100 c. c. to 150 c. c. of distilled water and 25 c. c. of the manganous sulphate mixture. Titrate with potas-

sium permanganate to the first pink color. The permanganate should be of such strength that 1 c. c. equals .005 gram of iron, or every c. c. should correspond to 1% iron, when one-half gram portion of the ore is taken.

SOLUTIONS.

Permanganate of Potassium.

122.3 grams dissolved in 43 litres of water.

Manganous Sulphate.

480 grams manganous sulphate, 10700 c. c. water, 1 litre phosphoric acid (85%) and 2800 c. c. strong sulphuric acid.

Permanganate Solution Values.

1 c. c. equals .005000 grams iron.

1 c. c. equals .002500 grams lime.

1 c. c. equals .001473 grams manganese.

1 c. c. equals .000814 grams phosphorus.

Stannous Chloride.

375 grams dissolved in 1 litre of water and

1 litre of strong hydrochloric acid.

Mercuric Chloride.

700 grams dissolved in 14 litres of water.

PHOSPHORUS. For Bessemer ores weigh five grams, for Non-Bessemer ores weigh one gram into a 250 c. c. beaker. Add 50 to 75 c. c. concentrated hydrochloric acid, cover with a watch glass and heat gradually to boiling, holding this temperature until the ore appears to be completely dissolved. Slightly raise the cover glass by means of a glass hook and evaporate the solution gradually until the mass becomes nearly dry; do not bake. Cool and add 15 c. c. of concentrated nitric acid. Heat gently until all the brown fumes are removed. Add 20 to 30 c. c. of hot water and filter into an Erlenmeyer's Flask (500 or 600 c. c. capacity). Wash the residue six times with hot water. Ignite the residue very strongly in a platinum crucible and return it into the beaker in which the original solution was made. Moisten with water and add 5 c. c. of concentrated nitric acid. Evaporate slowly until almost dry (about 1 c. c.). Dilute with hot water and filter into the main filtrate, which has in the meantime been concentrated to a small bulk (about 80 to 100 c. c.). The residue is discarded. The solution is made alkaline with strong ammonia and the precipitate of iron is dissolved with a very slight excess of strong nitric acid. Heat to 70° C. and add 40 c. c. of molybdate solution. Shake for five minutes, filter and wash six times with 2% nitric acid. Place about 10 to 15 grams of mossy zinc in the original flask, place the funnel in the flask and dissolve the vellow precipitate on the paper with two washings of ammonia (1 to 3) this

to be followed with two washings of water. Pour into the flask 150 to 200 c. c. of dilute sulphuric acid and heat gently for 20 minutes. Filter through a cotton plug into a titrating jar and wash the flask twice with water, and finally the cotton plug twice with water. Titrate with potassium permanganate of such a strength that 1 c. c. corresponds to .001628% phosphorus, when a 5 gram portion of the ore is taken.

SOLUTION.

Permanganate of Potassium.

122.3 grams dissolved in 43 litres of water.

Molybdate.

No. 1 Solution. 3750 c. c. strong nitric acid added to 6000 c. c. water, mix and cool.

No. 2 Solution. 750 grams molybdic acid (Merk's 85%) dissolved in a mixture of 1500 c. c. water and 1500 c. c. strong ammonia. Mix and cool. Add No. 2 Solution slowly, to No. 1 Solution, passing a current of air through the solution to thoroughly mix. Let stand for forty-eight hours before using.

MANGANESE. Three grams of the ore are dissolved by gentle heating, in 75 c. c. of concentrated hydrochloric acid in a 500 c. c. beaker, covered with a watch glass. When the solution is complete add 1 c. c. of nitric acid and 25 c. c. of dilute sulphuric acid, and hasten the evaporation by raising the watch glass slightly. Evaporate to white fumes of sulphuric acid. Cool, and add 150 to 200 c. c. of water, and heat to boiling. Boil five minutes and cool. When cool, transfer the solution to a graduated cylinder, add zinc oxide suspended in water, continuously shaking the solution until there is a slight excess, shown by the yellowish appearance of the precipitate formed. Dilute with water to exactly 600 c. c. in the graduated cylinder, mix the contents thoroughly by shaking, and filter. Of the filtrate take two portions, each 200 c. c., and place in Florence flasks (500 c. c. capacity). Heat to boiling and titrate while boiling, with potassium permanganate. 1 c. c. equals .001473 grams manganese or corresponds to .1473% manganese if one gram portion of the ore is taken.

SOLUTION.

Permanganate of Potassium.

122.3 grams dissolved in 43 litres of water.

SILICA. Fuse one gram of ore with ten grams of sodium carbonate in a capacious platinum crucible. Cool and dissolve the fusion in an evaporating dish with dilute hydrochloric acid. Cover the dish with a five-inch watch glass and evaporate to dryness. Cool, moisten with hydrochloric acid, evaporate and bake.

Cool, and add 30 c. c. of dilute hydrochloric acid, heat to boiling. When completely dissolved, filter and wash with hot dilute hydrochloric acid and hot water, alternately, until no iron stain shows. Weigh as silica.

ALUMINA. To the filtrate from the silica, add about 1 c. c. nitric acid and heat to boiling. Add strong ammonia in very slight excess, boil a minute and filter while hot. Wash thoroughly with hot water. Dissolve the precipitate on the paper with hot dilute hydrochloric acid, re-precipitate with ammonia, filter and wash. The filtrates are used for lime determination. The precipitate on the paper is dissolved with boiling hot dilute hydrochloric acid into a 600 c. c. beaker. Add strong ammonia with constant stirring until a deep mahogany color is obtained. If a precipitate is formed add a drop or two of dilute hydrochloric acid, until it is just dissolved, then add ammonia to the proper color. Add 3.3 c. c. of concentrated hydrochloric acid, 10 c. c. of a 10% ammonium phosphate solution, and 30 c. c. of a sodium hyposulphite solution (equivalent to 10 grams of the salt) followed by 5 c. c. of glacial acetic acid. Cover and heat gradually to boiling, with occasional stirring, and boil 15 minutes. Filter with moderate suction and wash eight times with boiling water. Ignite in a weighed porcelain crucible and weigh as aluminum phosphate. The weight times .4185 equals the weight of alumina.

SOLUTION.

Ammonium Phosphate.

100 grams dissolved in 1 litre of water.

LIME. The filtrate from the iron and alumina hydrates is evaporated to 150 or 200 c. c. and 10 c. c. of a saturated solution of ammonium oxalate added while boiling. Add 10 c. c. of strong ammonia and boil 10 minutes. Allow to stand in a warm place for two hours until completely settled, then filter through double papers washing eight times with hot water. Ignite in a weighed platinum crucible, finishing in a blast until the weight is constant. Cool in a dessicator and weigh as lime.

SOLUTION.

Ammonium Oxalate.

50 grams dissolved in 1 litre of water.

MAGNESIA. The filtrate from the calcium oxalate in the lime determination is made slightly acid with hydrochloric acid. Add 10 c. c. of ammonium phosphate solution. Cool and add drop by drop with constant stirring, 25 c. c. of concentrated ammonium hydrate and continue stirring a few minutes. Let stand in a cool place six hours, filter and wash with water containing

10% ammonia and 5% ammonium nitrate. Ignite in a porcelain crucible and weigh as magnesium pyro phosphate. Factor for magnesia is .3624.

SOLUTION.

Ammonium Phosphate.

225 grams dissolved in 1 litre of water.

SULPHUR. One gram of the ore is thoroughly mixed with ten grams of sodium carbonate and one gram of potassium nitrate. The mixture is heated carefully in a capacious platinum crucible over a blast lamp, until the fusion is quiet, then at the highest temperature of the lamp for a few minutes. The crucible is protected from contamination with sulphur in the gas by an asbestos shield. The fusion is thoroughly disintegrated in hot water, filtered and washed with hot water. The filtrate is made slightly alkaline with ammonia, again filtered and thoroughly washed. Two drops of methyl orange are added to the filtrate, and hydrochloric acid is added until the solution is just acid. After bringing to a boil, 5 c. c. of a barium chloride solution is added and the solution boiled for five minutes. After standing in a warm place for three hours the solution is filtered, washed with hot water, ignited in a platinum crucible, and weighed as barium sulphate, 13.74% of the weight being sulphur.

SOLUTION.

Barium Chloride.

100 grams dissolved in 1 litre of water.

Loss on Ignition.

One gram of the ore is placed in a weighed platinum crucible with a tightly fitting cover and heated to a bright red heat over a Bunsen Burner for fifteen minutes. Cool in a dessicator and weigh. Heat five minutes more and weigh, repeat until the weight remains constant. The loss in weight is the "Loss on Ignition."

Chapter IX

FUEL ENGINEERING.

Introduction.

The determination and location of preventable losses existing in the operation of any commercial enterprise, offers the most natural method of ultimately arriving at increased efficiency.

Under the general classification of Mechanical Engineering, that branch of the profession which has for its specific aim, the application of efficiency principles to the purchase of coal and subsequently to its economical utilization, has been termed Fuel Engineering.

The importance of this branch of the profession is rapidly growing in public favor. It is being more generally understood that the real basis of efficiency is educated common sense, which when properly directed, is responsible for the existance of certain manufacturing concerns, as it represents the difference between a profitable and an unprofitable enterprise.

The field for Fuel Engineering work is unlimited. It has its beginning with the purchase of the fuel best adapted to meet the conditions of the plant under consideration, continuing through the processes of combustion, until the evasive heat units originally contained in the fuel are made to record themselves at the switch-board or in the form of other work well performed.

METHOD OF CONDUCTING INVESTIGATION.

Boiler Plant Fuel.—As fuel may be considered the fulcrum about which revolve the underlying principles of fuel economy, it is of primary importance to first decide the character of fuel which will best meet the requirements of the plant and furnish heat and power at the minimum cost, all items considered. The general character of a given fuel is interpreted to mean its heating value, volatile and sulphur content and its caking and clinkering tendencies. Chemical and physical investigations will decide all of these factors with the exception of the latter, which must be arrived at by actual tests under boilers under varying load conditions.

Boiler Tests.—An important item in the investigation of a plant is reliable information as to efficiency of operation under existing conditions. This can only be arrived at by a series of tests.

Tests of this character will reveal the following valuable information:

- (1) Combined efficiency of boilers and grates.
- (2) Percentage of builders rated horsepower developed.

(3) Evaporation per pound of coal.

(4) Cost of evaporating a given quantity of water.

(5) Adaptability of fuel being used.

- (6) Heat balance.
- (7) Preventable waste.

The Heat Balance shows what portion of the total heat wasted may be reclaimed and added to the efficiency. The total loss may be due to the following:

- (1) Air excess.
- (2) Cold air leakage through settings.
- (3) Excessive radiation.
- (4) Incomplete combustion.
- (5) Combustible in refuse.
- (6) Loss due to products of combustion.

The extent to which these losses exist depends upon the boiler equipment and the comparative skill of the firemen. In order to cut these losses down to the minimum, it is necessary to know which are the most wasteful and to what extent they exist. With this information available it is perfectly feasible to stop the unnecessary leaks.

Boiler Plant Design.—Generally speaking the average commercial boiler plant is not given the same degree of consideration as is given the balance of the plant equipment. In view of the fact that the opportunity for improved economy in the boiler room is usually greater than in the engine room, this practice is open to criticism. The heat loss due to badly designed and poorly covered steam headers is considerable and more than generally believed. It is possible to calculate accurately these losses and estimate the saving to be realized by improvement in these respects. There are plants being operated continuously at a low degree of efficiency, where the yearly fuel consumption is double the actual cost of the boiler plant. In such instances the saving that would result from the installation of a modern plant would pay for the new plant in a comparatively short time.

ENGINE ROOM.

In equipping a plant with the required steam driven units the important features to observe are, reliability, service and economy. Each unit has a certain duty to perform. The importance of choosing the type and size of unit together with the necessary auxiliaries best suited to perform the imposed duty, cannot be over-estimated. It is unreasonable to expect that the equipment will continue to develope the maximum horsepower with the minimum steam consumption if it is not given the proper care and attention.

EXHAUST STEAM UTILIZATION.

In the case of non-condensing units it is essential to know what per cent of the heat in the exhaust steam is being returned to the feed-water. The only method of determining this fact is by recording the feed-water temperature covering a considerable period of time. It is not sufficient to assume that because the temperature is satisfactory during peak load periods it will continue to be equally satisfactory at other times. In order to develope completely the "back to the boiler system" it is necessary to know what resources are available and what the existing practice accomplishes. When consideration is given to the fact that exhaust steam is worth practically as much in heating value as expensive live steam, it is reasonable to assume that a complete knowledge of the characteristics of exhaust steam and of the factors connected with its utilization must constitute an important element in the ultimate efficiency and in the consumption of fuel.

The question of heating deserves consideration in this connection. With sufficient exhaust steam available, there is no economy in using live steam for heating purposes. Before going into this matter it is necessary to know the actual steam requirements for heating purposes, the quantity of exhaust steam available, the cost of making the proposed installation, and the probable net saving that will result. With this information, the feasibility of the improvement is put on a business basis.

In general, Fuel Engineering intelligently applied, is a source of large savings in the operation of any industrial power or heating plant. The possibility of making such a saving is often under-estimated or even unsuspected, and consequently, a small amount of money spent for the purpose of knowing accurately the extent of the saving which it is possible to attain with scientific operation is in a great majority of cases an investment rather than an expense. An efficient fuel engineer will be able to determine, after due consideration of the facts in any given case as he finds them, whether or not money spent for further investigation will be returned with profit in the form of saving in operating We have done a large amount of Fuel Engineering work, and it is our experience that in not one of the investigations made by us, has the cost of the investigation failed to be returned many times over by the saving which resulted from following our advice in matters pertaining to the scientific operation and management of power and heating plants, beginning with the first purchase of fuel and continuing through the train of operations to the final results obtained.

CHAPTER X. LOCATION AND DESCRIPTION OF MINES. VERMILION RANGE

CHANDLER MINE.

Location: St. Louis County, Minnesota, Section 28, Township

63, Range 12.

Description: First opened up in 1888. Two ores were shipped from this mine, CHANDLER, a Bessemer Hematite; and LONG LAKE, a Non-Bessemer Hematite. Underground system of mining was used. Greatest vertical depth 900 feet. The ore was shipped via the Duluth & Iron Range Railroad to Two Harbors, and from there to the lower lake ports by boat.

This mine was abandoned March 11th, 1909, but reopened in the same year and has been shipping since. The present depth of the workings is 400 feet, and the slicing system is used. The present ore is a Bessemer Hematite, and is not crushed. The ore is shipped via the D. & I. R. Railroad to Two Harbors, and thence by boat to lower lake ports.

Operating Company: Chandler Mining Co., Virginia, Minn.

Manager: John Costin Jr.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

1888—454,612 tons	1901—627,379 tons
1889—306,220 tons	1902—645,786 tons
1890—336,002 tons	1903—460,548 tons
1891—373,969 tons	1904—422,162 tons
1892—651,655 tons	1905—365,739 tons
1893—435,930 tons	1906—318,990 tons
1894—558,050 tons	1907—245,684 tons
1895—605,024 tons	1908— 50,639 tons
1896—471,545 tons	1909—
1897—438,365 tons	1910—
1898715,919 tons	1911— 50,206 tons
1899—808,359 tons	1912— 73,570 tons
1900—644,801 tons	1913— 51,403 tons
· Total.	Tons9.712.357

Analysis: The average of all cargo analyses for 1913 is as fol-

lows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 57.50 .042 11.30 .12 3.84 .33 :26 .006 1.78 The ore in its natural state is as follows:

Moist Iron Phos. Silica 6.00 54.05 .039 10.62

PIONEER MINE.

Location: St. Louis County, Minnesota, Section 27, Township 63, Range 12.

Description: First opened up in 1889. The mine ships two

grades of ore: PIONEER, a hard, red-brown, Bessemer Hematite; and FRONTIER, a hard, red-brown, Non-Bessemer Hematite. The ore is not crushed. The mine is worked by underground methods, the greatest vertical depth being 1,466 feet.

The ore is shipped via the D. & I. R. Railroad to Two Harbors, and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Ely, Minn.

General Manager: J. H. McLean.

General Superintendent: C. Trezona.

Yearly Shipments:

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1902—673,836 tons
1903—596,735 tons
1889-
          3,144 tons
1890— 12,012 tons
1891— 3,079 tons
                                                 1904-505,432 tons
                                                 1905-
1892-
          2,651 tons
                                                        -653,682 tons
                                                 1906—766,853 tons
1907—830,700 tons
1893-
1894
                                                 1908-477,506 tons
1895-
      - 40,054 tons
1896—149.073 tons
                                                 1909-477,226 tons
                                                1910—526,435 tons
1911—400,919 tons
1912—647,237 tons
1897—204,103 tons
1898—123,183 tons
1899—339,897 tons
1900-450,794 tons
                                                 1913—520.124 tons
1901-678,310 tons
                Total, Tons.......9,086,012
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Analysis: The average of all cargo analyses for 1913 is as fol-

lows: Dried at 212° F. Pioneer:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 62.75 .039 5.65 .13

Frontier:
Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Los. 60.45 .079 7.18 .17

The ore in its natural state is as follows:

Pioneer:

Moist Iron Phos. Silica 6.63 58.59 .036 5.43

Frontier:

Moist Iron Phos. Silica 6.92 56.26 .074 6.69

SAVOY MINE.

Location: St. Louis County, Minnesota, Section 26, Township 63, Range 12.

Description: First opened up in 1899. The ore, SAVOY-JURA, is a hard and soft, red-brown, Non-Bessemer Hematite, and is not crushed. The mine is worked by underground methods, the greatest vertical depth being 846 feet.

The ore is shipped via the D. & I. R. Railroad to Two Har-

bors, and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Ely, Minn.

General Manager: J. H. McLean. General Superintendent: C. Trezona.

Yearly Shipments:

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1899— 81,022 tons
1900—170,446 tons
1901—212,008 tons
                                                                    1907— 43,320 tons
1908— 82,521 tons
1909— 83,167 tons
1910— 59,875 tons
1902-243,937 tons
1903—169,616 tons
1904— 74,866 tons
1905— 91,775 tons
                                                                     1911— 87,964 tons
                                                                     1912- 90,528 tons
                                                                     1913— 74,971 tons
1906-106,933 tons
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Total, Tons......1,672,943

The average of all cargo analyses for 1913 is as fol-

Dried at 212° F. lows:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 60.73 .099 6.18 .13

The ore in its natural state is as follows:

Moist Iron Phos. Silica 5.78 57.22 .093

SECTION 30 MINE.

Location: Lake County, Minnesota, Section 30, Lots 4, 5 and 6, SE 1/4 of NW 1/4, Township 63, Range 11 West.

Description: First opened up about 1906 by Shagway Iron This mine ships two ores, SECTION 30, a Company. hard, brownish Non-Bessemer ore; SECTION 30 BESSE-MER, a semi-soft, bluish-brown, Bessemer ore. It is an underground mine, partly open cut; greatest vertical depth is 635 feet.

The ore is shipped via the Duluth & Iron Range Railroad to Two Harbors and from there to the lower lake ports by boat.

Operating Company: Section 30 Mining Company. Address: Section 30 Post-office, Minnesota.

Superintendent: Alfred Holter.

Sales Agents: Pickands, Mather & Company, Cleveland, Ohio. Yearly Shipments:

1906		1910— 51,650 tons
1907—		1911— 34,298 tons
1908—		1912—157,344 tons
1909		1913—136,359 tons

Total, Tons......379,651

Analysis: The average of all cargo analyses for 1913 is as fol-Dried at 212° F. lows:

Section 30: Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 58.10 .064 13.18 .08 1.74 .22 .009 1.25 .34 Section 30 Bess: Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 63.53 6.33 .045 .06 1.54 .28 .008 1.02

The ore in its natural state is as follows:

Section 30:

Moist Iron Phos. Silica 4.50 55.49 .061 12.59

Section 30 Bess:

Moist Iron Phos. Silica 5.06 60.32 .043 6.01

SIBLEY MINE.

Location: St. Louis County, Minnesota, Sections 26 and 27, Township 63, Range 12.

Description: First opened up in 1899. The mine ships two grades of ore: SAVOY, a hard and soft, blue, Bessemer Hematite; and SIBLEY-JURA, a hard and soft, red-brown, Non-Bessemer Hematite. The ore is not crushed. The mine is worked by underground methods, the greatest vertical depth being 1,285 feet. The ore is shipped via the D. & I. R. Railroad to Two Harbors, and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Ely, Minn.

General Manager: J. H. McLean. General Superintendent: C. Trezona.

Yearly Shipments:

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1899— 5,169 tons	1907—226,835	tons
1900— 4,670 tons	1908—127,544	tons
1901—	1909—151,009	tons
1902— 78.304 tons	1910—206,386	tons
1903—113,595 tons	1911— 1,899	
1904—122,783 tons	1912—309,076	
1905—251,170 tons	1913—249,255	tons
1906-271,496 tons		
	Tons2,119,191	

Analysis: The average of all cargo analyses for 1913 is as fol-

lows: Dried at 212° F.

Savoy:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 63.13 .038 5.79 .12

Sibley-Jura:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 60.73 .099 6.18 .13

The ore in its natural state is as follows:

Savov:

Moist Iron Phos. Silica 6.07 59.29 .035 5.43

Sibley-Jura:

Moist Iron Phos. Silica 5.78 57.21 .093 5.82

SOUDAN MINE.

Location: St. Louis County, Minnesota, Sections 27, 28, 32, 33 and 34, Township 62, Range 15.

Description: First opened in 1884. The ore, VERMILION LUMP, is a hard, steel-blue, Non-Bessemer Hematite. The ore is not crushed. The mine is worked by the underground methods. The greatest vertical depth is 1,249 feet. The ore is shipped via the D. & I. R. Railroad to Two Harbors, and thence by boat to lower lake ports.

Operating Company: The Oliver Iron Mining Co., Soudan, Minn.

General Manager: J. H. McLean.
General Superintendent: C. Trezona.

Yearly Shipments:

```
1899—457,732 tons
1900—325,020 tons
1884— 62,124 tons
1885—225,484 tons
1886—304,396 tons
1887—394,252 tons
1888—457,341 tons
                                                              1901-208,284 tons
                                                              1902-
                                                                        -275,168 tons
                                                              1903—175,114 tons
1904— 70,713 tons
1889-535,318 tons
                                                              1905-205,002 tons
1890-
        -532,000 tons
                                                              1906—146,503 tons
1907—102,977 tons
1908— 53,070 tons
1909— 74,862 tons
1891-
         -517,570 tons
-498,353 tons
1892-
1893-370,303 tons
1894—390,463 tons
                                                              1910— 75,511 tons
1911— 65,349 tons
1912— 88,714 tons
1895—432,760 tons
1896—448,707 tons
1897—592,196 tons
1898-426,040 tons
                                                              1913—100,885 tons
                    Total, Tons......8,612,311
```

Analysis: The average of all cargo analyses for 1913 is as fol-

lows: Dried at 212° F.

Iron Phos. Silica Mang Alum. Lime Magnes. Sulph. Loss 64.87 .137 4.98 .09

The ore in its natural state is as follows:

Moist Iron Phos. Silica .98 64.23 .135 4.93

SULLIVAN MINE.

Location: Lake County, Minnesota, Section 30, Township 63, Range 11.

Description: First opened up in 1912. The ore is a hard Hematite. The mine is not at present in operation. The ore will be shipped from Two Harbors.

Operating Company: Section Thirty Mining Co., Section 30 Post Office, Minn.

Superintendent: Alfred Holter.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

ZENITH MINE.

Location: St. Louis County, Minnesota, Section 27, Township 63, Range 12.

Description: First opened up in 1892. The ore, SAVOY, is a hard and soft, blue-brown, Bessemer Hematite, and is not crushed. The mine is worked by underground methods, the greatest vertical depth being 1,102 feet. The ore is shipped via the D. & I. R. Railroad to Two Harbors, and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Ely, Minn.

General Manager: J. H. McLean. General Superintendent: C. Trezona.

Yearly Shipments:

1892— 14,991 tons	1903—161,091 to	ns
1893— 14,388 tons	1904— 86,557 to	ns
1894	1905—109,818 to	
1895	1906—181,580 to	
1896— 18,765 tons	1907—235,751 to	ns
1897— 40,817 tons	1908— 50,264 to	
1898	1909—321,951 to	ns
1899— 79,323 tons	1910—283,320 to	ns
1900— 60,089 tons	1911—448,295 to	ns
1901— 60,082 tons	1912—468,684 to	
1902-167,205 tons	1913—433,603 to	ns
Total,	Tons3,236,574	

Analysis: The average of all cargo analyses for 1913 is as fol-

lows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 63.13 .038 5.79 .12

The ore in its natural state is as follows:

Moist Iron Phos. Silica 6.07 59.29 .035 5.43

MESABI RANGE

ADAMS MINE.

Location: St. Louis County, Minnesota, Sections 31, 36; Township 58, Ranges 17, 18.

Description: First opened up in 1895. This mine ships three grades of ore: GROUP 1, a soft, dark-brown, Bessemer Hematite; GROUP 4, a soft, yellow-brown, Non-Bessemer Hematite; GILWOOD, a soft, slate-colored siliceous Bessemer. The ore is not crushed. The mine is worked by underground and open-pit methods. The greatest vertical depth is 448 feet. The ore is shipped via the D. & I. R. Railroad to Two Harbors, and thence by boat to lower lake ports.

Operating Company: The Oliver Iron Mining Co., Eveleth, Minn.

General Manager: J. H. McLean.

General Superintendent: R. J. Mitchell.

Yearly Shipments:

1895— 59,141 tons	1905—1.140.984 tons
1896— 234,562 tons	1906—1,238,350 tons
1897— 170,738 tons	1907—1,136,513 tons
1898— 390,860 tons	1908— 765,592 tons
1899— 720,474 tons	1909—1,829,372 tons
1900— 777,346 tons	1910—1,258,295 tons
1901— 829,118 tons	1911— 411,268 tons
1902—1,242,923 tons	1912— 993,523 tons
1903—1,109,750 tons	1913—1,580,196 tons
1904— 940,105 tons	•
Total, Tons	16,8 2 9,110

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Gilwood:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 52.96 .038 15.50 .67

The ore in its natural state is as follows:

Gilwood:

Moist Iron Phos. Silica 11.88 46.66 .033 13.66

For analysis of Groups 1, 2 and 3; see Group Analysis.

ADRIATIC MINE.

Location: St. Louis County, Minnesota, Section 30, Township 59, Range 14.

Description: First opened up in 1906. The ore is a soft, red.

Non-Bessemer Hematite and is not crushed.

The mine is worked by the underground slicing system.

The greatest vertical depth is 155 feet. The ore is shipped via the D. & I. R. Railroad to Two Harbors, Minn., and thence by boat to lower lake ports.

Operating Company: Adriatic Mining Co., Cleveland, Ohio.

Manager: R. M. Sellwood. Superintendent: Wm. Mudge.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

1906- 3,294 tons	1910—135,685 tons
1907— 70,187 tons	1911— 73,280 tons
1908—108,129 tons	1912—102,478 tons
1909—107,307 tons	1913—110,534 tons
Total, To	ons710.904

Analysis: The average of all cargo analyses for 1913 is as fol-

Dried at 212° F. lows:

Mang. Alum. Lime Magnes. Sulph. Phos. Silica Iron Loss 55.60 10.88 .34 2.09 6.31

The ore in its natural state is as follows:

Moist Iron Phos. Silica 11.50 49.21 .069

AGNEW MINE.

Location: St. Louis County, Minnesota, N. E. 1/4 of N. E. 1/4, Section 11, Township 57 North, Range 21 West.

Description: First opened up in 1902. This ore is a soft, red Bessemer Hematite. It is an open pit mine.

The ore is shipped via the Great Northern Railway to Superior, and from there by boat to the lower lake ports.

Operating Company: The Wisconsin Steel Co., Harvester bldg., Chicago, Illinois.

Manager: R. M. Sellwood, Duluth, Minnesota.

Superintendent: M. Trewhalla, Hibbing, Minnesota. Sales Agents: Wisconsin Steel Company, Chicago, Ill.

Yearly Shipments:

1902— 45,582 tons	1908—164,486	tons
1903—108,847 tons	, 1909—151,536	tons
1904— 96,435 tons	1910—152,834	tons
1905— 44,651 tons	1911—153,425	
1906—163,260 tons	1912—101,498	
1907—149,084 tons	1913—101,549	tons
Total	Tons 1 433 186	

The average of all cargo analyses for 1913 is as fol-Dried at 212° F. Analysis:

lows:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 58.26 10.69 .52 1.57 .035

The ore in its natural state is as follows:

Moist Iron Phos. Silica 14.05 50.07 .030 9.18

AJAX MINE—(Formerly Kanawha Mine).

Location: St. Louis County, Minnesota, Section 1, Township 58, Range 16.

Description: First opened up in 1889. Not at present in operation. The ore is a soft, brownish, Non-Bessemer Hematite. The mine is an open-pit. Greatest vertical depth is 125 feet. The ore was not crushed. The ore was shipped via the D. & I. R. Railroad to Two Harbors and thence by boat to lower lake ports.

Operating Company: Ajax Mining Co., Duluth, Minn. Sales Agents: Pickands, Mather & Co., Cleveland, Ohio. Yearly Shipments:

1899—14,965 to:	ns	1903-23,932	tons
1900-64,218 to	ns	1904— 912	tons
1901—41,300 to	ns	1905—28,439	tons
1902—24,829 to:	ns	1906— 9,057	tons
· Ta	otal. Tons207	.6 5 0	

ALBANY MINE.

Location: St. Louis County, Minnesota, Section 32, Township 58, Range 20.

Description: First opened up in 1903. This mine ships three grades of ore: ALBANY, a soft, yellow, Non-Bessemer Hematite; CRETE, a soft, red, Bessemer Hematite; ALBANY REX, a soft, blue, Non-Bessemer Hematite. The ore is not crushed.

The mine is worked by the milling system.

The greatest vertical depth is 260 feet. The ore is shipped via the D. M. & N. and Great Northern railroads to Duluth and Superior, thence by boat to lower lake ports.

Operating Company: Crete Mining Co., Cleveland, Ohio.

Manager: C. H. Munger. Superintendent: Robt. Murray.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

p	
1903—109,608 tons	1909—368,057 tons
1904—153,433 tons	1910—267,583 tons
1905—241,186 tons	1911—132,572 tons
1906—356,371 tons	1912—244,669 tons
1907—437,521 tons	1913—345,162 tons
1908— 64.860 tons	•

Total, Tons......2,721,022

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Albany:

Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sulph.	Loss
58.90	.069	5.54	.78	1.56	.26	.21	.008	7.17

Crete: Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 60.50 7.08 .057 4.23 .48 1.18 .21 .17 .007 Albany-Rex: Silica Alum. Iron Phos. Mang. Lime Magnes. Sulph. Loss 2.52 55.50 .096 6.17 2.84 .28 .21 7.50 The ore in its natural state is as follows: Albany: Moist Iron Phos. Silica 13.00 51.24 .060 4.82 Crete: Moist Phos. Silica Iron 12.00 53.24 .050 3.72 Albany-Rex: Silica Moist Iron Phos. 13.75 47.87 .083

AUBURN MINE.

Location: St. Louis County, Minnesota, Section 20, Township 58, Range 17.

Description: First opened up in 1894. Two ores were shipped from this mine, Bessemer and Non-Bessemer Hematite. Operated by The Oliver Iron Mining Company. Now idle.

Yearly Shipments:

1894—108,210 tons	1899—385,992	tons
1895—376,970 tons	1900263,692	tons
1896—131,478 tons	1901—427,510	tons
1897—175,263 tons	1902— 38,283	tons
1898—235,630 tons	·	
Total	Tone 2 1/3 029	

Total, Tons.......2,143,028

BANGOR MINE.

Location: St. Louis County, Minnesota, Sections 1, 6; Township 58, Ranges 15, 16.

Description: First opened up in 1910. The ore is a soft, red, Non-Bessemer Hematite and is not crushed.

The mine is worked by the underground slicing system.

The greatest vertical depth is 323 feet. The ore is shipped via the D. & I. R. Railroad to Two Harbors, and thence by boat to lower lake ports.

Operating Company: Bangor Mining Co., Cleveland, Ohio.

Manager: C. H. Munger. Superintendent: W. P. Chinn.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

1910— 17,736 tons 1912—130,997 tons 1911—119,508 tons 1913—119,705 tons Total, Tons......387,946

Analysis: The average of all cargo analyses for 1913 is as fol-

lows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 56.40 .065 9.62 .60 2.32 .27 .22 .007 6.15

The ore in its natural state is as follows:

Moist Iron Phos. Silica 14.00 48.50 .056 8.27

BELGRADE MINE—(Formerly Kellogg).

Location: St. Louis County, Minnesota, Section 9, Township 58, Range 16.

Description: First opened up in 1908. The ore is soft, red, Bessemer and Non-Bessemer Hematite. The ore is not crushed. The mine is worked by the underground slicing system. The greatest vertical depth is 222 feet. The ore is shipped via the D. & I. R. Railroad to Two Harbors and thence by boat to lower lake ports.

Operating Company: The Balkan Mining Co., Cleveland, Ohio.

Manager: C. H. Munger.

Superintendent: W. P. Chinn.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

 1908—31,331 tons
 1911—113,038 tons

 1909—165,458 tons
 1912—127,412 tons

 1910—142,906 tons
 1913—

 Total, Tons............580,145

Analysis: The expected analysis for season of 1914 is as fol-

lows: Dried at 212° F.

 Iron
 Phos. Silica
 Mang. Alum. Lime
 Magnes. Sulph. Loss

 60.65
 .035
 9.39
 .37
 .79
 .16
 .15
 .017
 2.62

The ore in its natural state is as follows:

Moist Iron Phos. Silica 9.40 54.95 .032 8.51

BENNETT MINE.

Location: Itasca County, Minnesota, Section 24, Township 57, Range 22.

Description: First opened up in 1912. The mine ships two ores: BENNETT, a soft, dark-brown, Non-Bessemer Hematite; and MERIDEN, a soft, blue, Bessemer Hematite. The mine is worked by open-pit and underground methods. The greatest vertical depth is 173 feet. The ore is shipped via the Great Northern Railway to Allouez Bay, and thence by boat to lower lake ports.

Operating Company: Keewatin Mining Co., Hibbing, Minn.

Manager: O. B. Warren. Superintendent: J. M. Drake.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

1913-88,931 tons 1912—

Total, Tons.......88,931

The average of all cargo analyses for 1913 is as fol-Dried at 212° F. Analysis: lows:

Bennett:

Mang. Alum. Lime Magnes. Sulph. Loss Iron Phos. Silica 7.50 .96 .31 .23 .018 5.59 57.00 .085 *Meriden:

Silica Mang. Alum. Lime Magnes. Sulph. Loss Iron Phos. 4.50 2.00 .23 .018 56.50 .048 11.50 .50 .16 The ore in its natural state is as follows:

Bennett:

Iron Phos. Silica Moist 10.50 51.02 .076

*Meriden:

Phos. Silica Moist Iron 10.00 50.85 .043 10.35

BESSEMER MINE.

Location: St. Louis County, Minnesota, Section 9, Township 58,

Range 17.

Description: First opened up in 1904. Two grades of ore are shipped from this mine, a soft, red, Bessemer and Non-Bessemer Hematite. Slicing system of mining used. Greatest vertical depth, 210 feet.

The ore is shipped via the Duluth & Iron Range Railroad to Two Harbors, Minnesota, and from there by boat to the lower lake ports.

Sales Agents: M. A. Hanna & Company, Cleveland, Ohio.

Yearly Shipments:

1904— 86,303 tons	1909—227,767	tons
1905—112,630 tons	1910—117,173	
1906—131,791 tons	1911—179,051	
1907— 78,012 tons	1912—136,010	tons
1908—120,350 tons	1913—	
Total.	Tons1.089.087	

BIWABIK MINE.

Location: St. Louis County, Minnesota, Sections 2 and 3, Town-

ship 58, Range 16.

Description: First opened up in 1893. This mine ships two ores, BIWABIK, a Bessemer Hematite and SHILLING, a Non-Bessemer Hematite.

^{*}Expected analysis for 1914.

The ore is shipped via the Duluth & Iron Range Railroad to Two Harbors, and from there by boat to the lower lake ports.

Sales Agents: The Tod-Stambaugh Company, Cleveland, Ohio. Yearly Shipments:

```
1893-
      - 151,500 tons
                                                     - 647,614 tons
-1,092,987 tons
                                               1904-
1894
          90,048 tons
                                               1905
1895
         247,069 tons
                                               1906
                                                        807,374 tons
                                                       803,750 tons
365,781 tons
542,821 tons
1896
         242,565 tons
                                               1907-
         427.464 tons
1897-
                                               1908
1898-
         383,180 tons
                                               1909-
1899-
         553.836 tons
                                              1910-
                                                        544,355 tons
         924,868 tons
1900-
                                              1911-
                                                       211,071 tons

410,074 tons
623,127 tons

1901-
                                              1912-
                                                        312,378 tons
1902
                                                       300,924 tons
                                              1913-
1903-
      - 905,511 tons
               Total, Tons......10,490,295
```

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Biwabik:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 61.40 .041 5.15 .52 1.03 .27 .26 .016 4.77 Shilling:

Phos. Iron Silica Mang. Alum. Lime Magnes. Sulph. Loss 58.35 .082 5.75 .69 1.85 .21 .12 .010 7.34 The ore in its natural state is as follows:

Biwabik:

Moist Iron Phos. Silica 9.55 55.54 .037 4.66

Shilling:

Moist Iron Phos. Silica 12.69 50.95 .072 5.02

BRAY MINE.

Location: Itasca County, Minnesota, Section 23, Township 57, Range 22.

Description: First opened up in 1909. The ore is a soft, red, Non-Bessemer Hematite and is not crushed.

The mine is worked by steam-shovel and slicing methods.

The greatest vertical depth is 124 feet. The ore is shipped via the Great Northern Railway to Allouez Bay, and thence by boat to lower lake ports.

Operating Company: Republic Iron & Steel Co., Youngstown, Ohio.

Manager: F. J. Webb.

Superintendent: Nels Johnson.

Sales Agents: Oglebay-Norton & Co., Cleveland, Ohio.

Yearly Shipments:

1909— 65,514 tons 1910— 57,789 tons 1911-

1912-164,732 tons 1913-102,439 tons

Total, Tons......390,474

The average of all cargo analyses for 1913 is as fol-Analysis: Dried at 212° F.

Mang. Alum. Phos. Silica Lime Magnes. Sulph. Loss Iron 58.00 .061 8.00 1.25 3.00 .18 .14 .021 4.00

Bray No. 2:

Lime Magnes. Sulph. Phos. Silica Mang. Alum. Loss Iron .14 55.50 11.50 1.50 3.10 . .13 .018 4.72 .061 The ore in its natural state is as follows:

Moist Iron Phos. Silica 13.50 50.17 .053 6.92

Bray No. 2:

Moist Iron Phos. 14.00 47.73 .052

BRUNT MINE.

Location: St. Louis County, Minnesota, Section 10, Township 58, Range 18.

Description: First opened up in 1906. The ore is a soft red, Bessemer and Non-Bessemer Hematite. Open pit steam shovel mining is used. Ore is shipped via the D. M. & N. Railway to Duluth, and from there by boat to the lower lake ports.

Operating Company: Pittsburgh Iron Ore Co. Address: Virginia, Minnesota.

Manager: James D. Ireland. Superintendent: C. E. Hendrick.

Sales Agents: M. A. Hanna & Co., Cleveland, Ohio.

Yearly Shipments:

1906— 75,401 tons 1907—178,935 tons 1910-110,630 tons 1911—136,531 tons 1912—215,585 tons 1913—202,969 tons 1908— 636 tons 1909— 14,212 tons Total, Tons..........934,699

Analysis: The average of all cargo analyses for 1913 is as fol-

Dried at 212° F. lows:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 55.00 .049 9.70 .93 4.71 .20 .20 .150 5.50

The ore in its natural state is as follows:

Moist Iron Phos. Silica 49.90 .044 8.80

BURT MINE.

Location: St. Louis County, Minnesota, Sections 31 and 36; Township 58, Ranges 20 and 21.

Description: First opened up in 1895. The mine ships five grades of ore:

GROUP 2, soft, gray-black, Bessemer Hematite.

GROUP 3, soft, brownish-yellow, Non-Bessemer Hematite.

GROUP 5, soft, gray-black, Bessemer Hematite.

GROUP 7, soft, yellowish-red Non-Bessemer Hematite. GROUP 9, soft, yellowish-red Non-Bessemer Hematite.

The ore is not crushed. The mine is an open-pit. The ore is shipped via the D. M. & N. Railway to Duluth, and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Hibbing, Minn.

General Manager: J. H. McLean. General Superintendent: W. J. West.

Yearly Shipments:

Analysis: See analyses of Groups 2, 3, 5, 7 and 9.

CANISTEO MINE.

Location: Itasca County, Minnesota, Sections 29, 30 and 31, Township 56, Range 24.

Description: First opened up in 1907. This mine ships four ores: GROUPS 2 and 5, soft, brown, Bessemer Hematite. GROUPS 3 and 7, soft, brown, Non-Bessemer Hematites. The ore is not crushed. The mine is an open-pit. The greatest vertical depth is 221 feet. The ore is shipped via the D. M. & N. Railway to Duluth, and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Coleraine, Minn. General Manager: J. H. McLean.

General Superintendent: L. R. Salsich.

Yearly Shipments:

1907— 5,454 tons 1911—1,340,378 tons 1908— 2,760 tons 1912—2,099,880 tons 1909— 85,505 tons 1913—1,099,727 tons 1910—1,105,160 tons Total, Tons......5,738,864

Analysis: See analyses of Groups 2, 3, 5 and 7.

CANTON MINE.

Location: St. Louis County, Minnesota, Section 3, Township 58, Range 16.

Description: First opened up in 1893. The ore is a Bessemer Hematite.

Operated by the Oliver Iron Mining Company.

Yearly Shipments:

1893— 24,416 tons 1894—213,853 tons 1897-1898-1895-359,020 tons 1899-- 99,498 tons 1896— 16,261 tons

Total, Tons.........713,048

CAVOUR MINE.

Location: St. Louis County, Minnesota, Section 15, Township 58, Range 19.

Description: First opened up in 1910. The ore is a soft, brown, Non-Bessemer Hematite and is not crushed. The mine is worked by underground methods. The greatest vertical depth is 180 feet. The ore is shipped via the Great Northern Railway to Allouez Bay, and thence by boat to lower lake

Operating Company: Cavour Mining Co., Hibbing, Minn.

Manager: J. C. Agnew.

Superintendent:. C. H. Claypool.

Sales Agents: Oglebay-Norton & Co., Cleveland, Ohio.

Yearly Shipments:

1911— 1,104 tons 1912— 47,919 tons 1913-118,404 tons

Total, Tons.......167,527

The average of all cargo analyses for 1913 is as fol-Dried at 212° F. Analysis:

lows:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. 57.58 .082 8.47 .72 2.47 .22 .21 .006 4.64

The ore in its natural state is as follows:

Moist Iron Phos. Silica 11.74 50.82 .072

CHISHOLM MINE.

Location: St. Louis County, Minnesota, Section 28, Township

58, Range 20.

Description: First opened up in 1901. The mine ships three

grades of ore:

GROUP 2, a soft, dark-brown, Bessemer Hematite. .

GROUPS 3 and 7, soft, dark-red, Non-Bessemer Hematites. The ore is not crushed. The mine is worked by underground methods. The greatest vertical depth is 255 feet. The ore is shipped via the Great Northern Railway to Superior, and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Chisholm, Minn.

General Manager: J. H. McLean.

General Superintendent: A. J. Sullivan.

Yearly Shipments:

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1901— 34,563 tons 1908—228,386 tons 1902—200,629 tons 1909—314,597 tons 1903—168,831 tons 1910—634,236 tons 1904—130,732 tons 1911—721,784 tons 1905—231,296 tons 1912—695,859 tons 1906—379,156 tons 1913—641,788 tons 1907—258,793 tons
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Total, Tons......4,640,660

Analysis: See analyses of Groups 2, 3, 7, 8 and 9.

CLARK MINE.

Location: St. Louis County, Minnesota, Section 28, Township 58, Range 20.

Description: First opened up in 1900. The mine ships four grades of ore:

GROUP 2, a soft, dark-brown, Bessemer Hematite.

GROUPS 3, 7 and 9, soft, dark-yellow, Non-Bessemer Hematites.

The ore is not crushed. The mine is worked by underground methods. The greatest vertical depth is 201 feet.

The ore is shipped via the D. M. & N. and Great Northern Railways to Duluth and Superior, and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Chisholm, Minn. General Manager: J. H. McLean.

General Superintendent: A. J. Sullivan.

Yearly Shipments:

```
    1900—63,071 tons
    1907—319,938 tons

    1901—199,566 tons
    1908—334,594 tons

    1902—350,799 tons
    1909—484,512 tons

    1903—300,492 tons
    1910—529,222 tons

    1904—256,873 tons
    1911—500,999 tons

    1905—351,091 tons
    1912—500,768 tons

    1906—274,394 tons
    1913—402,893 tons

    Total, Tons
    4,876,257
```

Total, Tons.....4,070,257

Analysis: See analyses of Groups 2, 3, 7 and 9.

COLUMBIA MINE.

Location: St. Louis County, Minnesota, Section 6, Township 58, Range 17.

Description: First opened up in 1901. The ore is a soft, Non-Underground system of mining was Bessemer Hematite. used. Greatest vertical depth 160 feet.

The ore was shipped via the Great Northern Railway to Superior, and from there by boat to the lower lake ports.

Sales Agent: W. G. Pollock, Cleveland, Ohio.

Yearly Shipments:

1901—15,627 tons 1905—1,360 tons Total, Tons.......16,987

COMMODORE MINE.

Location: St. Louis County, Minnesota, Section 9, Township 58, Range 17.

Description: First opened up in 1893. Two ores are shipped from this mine, ADMIRAL, a soft, blue, Bessemer Hematite and COMMODORE, a soft, blue, Non-Bessemer Hematite. Open pit system of mining is used.

The ore is shipped via the Great Northern Railway to Allouez Bay and from there by boat to the lower lake ports.

Sales Agents: Corrigan, McKinney & Company, Cleveland, Ohio.

Yearly Shipments:

1893— 65,137	tons		1904	249 ton	S
1894— 7,213	tons		1905—146,	901 ton:	s
1895			1906-263,	401 tons	s
1896 22,063	tons	•	1907-477.	203 tons	S
1897— 60,798	tons		1908-116,	069 ton:	s
1898— 80,494	tons		1909409	148 ton:	s
1899—152,947	tons		1910-341.	548 ton:	s
1900-278,416	tons		1911-294	787 ton:	s
1901— 35,546			1912-567	855 ton:	s
1902— 65,833			1913-484		
1903— 20,436					-

The average of all cargo analyses for 1913 is as fol-Analysis: Dried at 212° F. lows:

Admiral:

Mang. Iron Phos. Silica Alum. Lime Magnes. Sulph. Loss 60.73 .037 6.55 .48 .85 .83 .60 .008 3.55 Commodore: Iron Phos.

Loss Silica Mang. Alum. Lime Magnes. Sulph. 58.10 7.45 .60 1.90 .009 .058 .78 .45 5.40 The ore in its natural state is as follows:

Admiral:

Moist Iron Phos. Silica 9.75 54.81 .033 5.91

Commodore:

Moist Iron Phos. Silica 10.70 51.88 .052 6.65

CORSICA MINE.

Location: St. Louis County, Minnesota, Section 18, Township 58, Range 16.

Description: First opened up in 1901. This mine ships two grades of ore:

CORSICA-BESSEMER, a soft, red, Bessemer Hematite. CORSICA-NON-BESSEMER, a soft, red, Non-Bessemer Hematite.

The ore is not crushed. The mine is worked by the underground slicing system. The greatest vertical depth is 192 feet.

The ore is shipped via the D. & I. R. Railroad to Two Harbors and thence by boat to lower lake ports.

Operating Company: Corsica Iron Co., Cleveland, Ohio.

Manager: C. H. Munger. Superintendent: W. P. Chinn.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

omparence.	
1901— 26,838 tons	1908— 77,674 tons
1902— 59,292 tons	1909—135,366 tons
1903— 34,043 tons	1910—277,537 tons
1904— 30,131 tons	1911— 63,940 tons
1905—	1912—196,188 tons
1906—100,606 tons	1913—225,140 tons
1007172 226 tone	•

Total, Tons......1,398,981

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Corsica-Bessemer:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 58.30 .044 9.33 .42 1.59 .23 .21 .009 4.64

Corsica-Non-Bessemer:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 55.10 .059 11.43 .58 2.56 .26 .19 .010 6.01 The ore in its natural state is as follows:

Corsica-Bessemer:

Moist Iron Phos. Silica 10.00 52.47 .039 8.39

Corsica-Non-Bessemer:

Moist Iron Phos. Silica 13.50 47.66 .051 9.88

CROSBY MINE.

Location: Itasca County, Minnesota, Sections 31 and 32, Township 57, Range 22.

Description: First opened up in 1903. The ore is a Bessemer Hematite, and is not crushed. The mine is worked by open-

pit and caving methods. The greatest vertical depth is 90 feet. The ore is shipped via the Great Northern Railway to Superior, and thence by boat to lower lake ports.

Operating Company: The Cleveland-Cliffs Iron Co., Cleveland, Ohio.

Manager: M. M. Duncan.

Superintendent: Max H. Barber.

Sales Agents: The Cleveland-Cliffs Iron Co., Cleveland, Ohio.

Yearly Shipments:

1906—115,373 tons 1907—227,265 tons 1908—152,084 tons 1909—183,470 tons 1910-159,569 tons 1911— 18,439 tons 1912—188,368 tons 1913—219,065 tons Total, Tons......1,263,633

Analysis: The expected analysis for season of 1914 is as follows:

Dried at 212° F.

Phos. Silica Mang. Alum. Lime Magnes. Sulph. .80 .90 .32 .15 .011 Iron 59.60 .044 7.64 The ore in its natural state is as follows:

Moist Iron Phos. Silica

9.00 54.24 .040 6.95

CROXTON MINE.

Location: St. Louis County, Minnesota, Section 13, Township 58, Range 20.

Description: First opened up in 1902. The ore is a soft, red, Non-Bessemer Hematite. Underground method of mining was used. Mine is exhausted.

Ore is shipped via Great Northern Railway to Allouez Bay, and from there by boat to the lower lake ports.

Operating Company: Croxton Mining Co. Address: Virginia, Minn. Manager: James D. Ireland. Superintendent: C. E. Hendrick.

Sales Agents: M. A. Hanna & Co., Cleveland, Ohio.

Yearly Shipments:

1902— 18,594 tons	1908—154,868	tons
1903—100,297 tons	1909—159,038	tons
1904— 348 tons	1910— 71,632	tons
1905—130,228 tons	1911— 10,491	
1906—162,533 tons	1912—146,290	tons
1907—349,853 tons	1913— 50,033	tons
Total,	Tons1,354,205	_

CYPRUS MINE.

Location: St. Louis County, Minnesota, Section 3, Township 57, Range 21.

Description: First opened up in 1903. This mine ships two grades of ore: CYPRUS, a soft, red, Non-Bessemer Hematite and ATHENS, a soft, red, Bessemer Hematite. The ore is not crushed.

The mine is worked by the open-pit system.

The ore is shipped via the Great Northern Railway to Superior, and thence by boat to lower lake ports.

Operating Company: Cyprus Mining Co., Cleveland, Ohio.

Manager: R. M. Sellwood.
Superintendent: Wm. Gardne

Superintendent: Wm. Gardner.
Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

```
    1903—121,818 tons
    1909—107,685 tons

    1904—244,343 tons
    1910—102,233 tons

    1905—235,351 tons
    1911—81,178 tons

    1906—192,144 tons
    1912—100,063 tons

    1907—260,948 tons
    1913—82,121 tons

    1908—115,745 tons
```

Total, Tons..........1,643,629

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Cyprus:

Íron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 58.70 .051 7.92 .009 4.86 .64 1.93 .27 .24 Athens:

 Iron
 Phos.
 Silica
 Mang.
 Alum.
 Lime
 Magnes.
 Sulph.
 Loss

 59.20
 .037
 9.62
 .28
 1.07
 .24
 .19
 .007
 4.04

The ore in its natural state is as follows:

Cyprus:

Moist Iron Phos. Silica 12.00 51.66 .045 6.97

Athens:

Moist Iron Phos. Silica 10.00 53.28 .033 8.66

DALE MINE.

Location: St. Louis County, Minnesota, Section 3, Township 57, Range 21.

Description: First opened up in 1911. This mine ships three grades of ore:

GROUP 2, a soft, brownish-black, Bessemer Hematite.

GROUP 3, a soft, yellowish-brown, Non-Bessemer Hematite.

GROUP 8, a soft, grayish-yellow, Bessemer Hematite.

The ore is not crushed. The mine is worked by the open-pit system.

The ore is shipped via the D. M. & N. Railroad to Duluth, and thence by boat to lower lake ports.

Operating Company: The Oliver Iron Mining Co., Hibbing, Minn.

General Manager: J. H. McLean. General Superintendent: W. J. West.

Yearly Shipments:

1913— 621,415 tons

Analysis: See analyses of Groups 2, 3 and 8.

DAY MINE.

Location: St. Louis County, Minnesota, Section 31, Township 58, Range 20.

Description: First opened up in 1898. Bessemer and Non-Bessemer Hematite ores were shipped.

The mine was operated by The Oliver Iron Mining Company. Now idle.

Yearly Shipments:

1898— 18,651 1899— 1,975 1900—		1902—106,516 1903—107,781 1904— 84,530	tons
	tons		

Total, Tons......319,453

DULUTH MINE.

Location: St. Louis County, Minnesota, Section 3, Township 58, Range 16.

Description: First opened up in 1893. The ore is a soft, brown, Bessemer Hematite. Greatest vertical depth 114 feet. The ore is shipped via the Duluth & Iron Range Railroad to

Two Harbors and from there by boat to the lower lake ports. This mine is operated by The Oliver Iron Mining Company.

Yearly Shipments:

1893— 37,626 tons	1902—150,220 tons
1894	1903—150,053 tons
1895—	1904—149,819 tons
1896—	1905—142,172 tons
1897—	1906—158,336 tons
1898—112,155 tons	1907— 93,120 tons
1899—165,435 tons	1908—149,185 tons
1900-128,587 tons	1909—150,501 tons
1901—150,024 tons	1910— 57,239 tons
Total Tons	1 794 472

ELBA MINE.

Location: St. Louis County, Minnesota, Section 13, Township 58, Range 17.

Description: First opened up in 1898. The ore is soft, red, Bessemer Hematite.

The mine is worked by the underground slicing system.

The greatest vertical depth is 340 feet. The ore is shipped via the D. & I. R. Railroad to Two Harbors, and thence by boat to lower lake ports.

Operating Company: Hobart Iron Co., Cleveland, Ohio.

Manager: C. H. Munger.

Superintendent: W. P. Chinn.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

```
    1898—
    564 tons
    1906—255,580 tons

    1899—
    9,547 tons
    1907—134,488 tons

    1900—121,707 tons
    1908—147,916 tons

    1901—224,630 tons
    1909—224,202 tons

    1902—207,454 tons
    1910—186,993 tons

    1904—123,425 tons
    1912—168,990 tons

    1905—125,724 tons
    1913—126,236 tons

    2316,127
    2316,127

    2316,137
    2316,137
```

Total, Tons......2,316,127

Analysis: The average of all cargo analyses for 1913 is as fol-

lows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 58.30 .040 9.34 .82 1.11 .24 .18 .007 4.74
The ore in its natural state is as follows:

The ore in its natural state is as follows:

Moist Iron Phos. Silica 10.00 52.47 .036 8.41

EUCLID MINE.

Location: St. Louis County, Minnesota, Section 21, Township 58, Range 20.

Description: First opened up in 1909. Two ores are shipped from this mine, EUCLID, a soft, dark-brown, Non-Bessemer Hematite, and MADEIRA, a soft, dark-brown, Bessemer Hematite.

The ore is shipped via the Great Northern Railway to Allouez Bay and from there by boat to the lower lake ports.

Operating Company: Euclid Iron Mining Co., Virginia, Minn.

General Manager: A. B. Coates.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

```
1909— 82,637 tons 1912— 49,590 tons 1910— 53,009 tons 1913— 1911— 56,796 tons Total, Tons.......242,032
```

Analysis: The expected analysis of EUCLID ore for season of 1914 is as follows: Dried at 212° F. Phos. Silica Mang. Alum. Lime Magnes. Sulph. 57.50 .076 6.75 .90 2.42 .31 The ore in its natural state is as follows: .25 Moist Iron Phos. Silica 12.50 50.31 .066 5.91

FAYAL MINE.

Location: St. Louis County, Minnesota, Sections 5 and 6, Town-

ship 57, Range 17.

First opened up in 1895. This mine ships two Description: grades of ore:

GROUP 1, soft, brown, Bessemer Hematite.

GROUP 4, soft, yellow, Non-Bessemer Hematite.
The ore is not crushed. The mine is worked by underground and open-pit methods. The greatest vertical depth is 289 feet.

The ore is shipped via the D. & I. R. Railroad to Two Harbors, and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Eveleth, Minn. General Manager: J. H. McLean.

General Superintendent: R. R. Trezona.

Yearly Shipments:

p			
1895— 136,601	tons	1905-1,358,922	tons
1896 248,645	tons .	1906—1,634,853	tons
1897— 642,939		1907—1,878,812	
1898— 575,933		1908—1,439,879	
1899—1,072,257		1909—1,879,357	
1900—1,252,504		1910—1,485,099	
1901—1,656,973		1911— 434,364	
1902—1,919,172		1912— 468,019	
1903—1,460,601		1913—1,257,430	tons
1904— 975.102	tons		

Total, Tons......21,777,462

Analysis: See analyses of Groups 1 and 4.

FOREST MINE.

Location: Itasca County, Minnesota, S. E. 1/4 of N. W. 1/4, Section 13, Township 57, Range 22.

Description: First opened up in 1904. The ore is a soft, red Bessemer Hematite. Open pit system of mining was used. Greatest vertical depth 65 feet.

The ore was shipped via the Great Northern Railway to Allouez Bay and from there by boat to the lower lake ports.

Sales Agents: M. A. Hanna & Company, Cleveland, Ohio.

Yearly Shipments:

1904— 85,280 tons		6,304 tons
1905— 99,785 tons	1910	8,264 tons
1906— 41,647 tons	1911—	•
1907— 4,840 tons	1912—	
1908— 2,420 tons	1913—	
Total,	Tons248,540	

FOWLER MINE.

Location: St. Louis County, Minnesota, Section 3, Township 58, Range 15.

Description: First opened up in 1907. The ore is a soft, yellow, Non-Bessemer Hematite. Caving and slicing systems of mining are used. Greatest vertical depth 132 feet.

The ore is shipped via the Duluth & Iron Range Railroad to Two Harbors and from there by boat to the lower lake

Sales Agent: W. G. Pollock, Cleveland, Ohio.

Yearly Shipments:

1907— 34,014 tons 1908— 21,511 tons 1909— 99,892 tons	1911— 85,506 to · 1912—204,584 to 1913— 72,087 to	ns
1910—204,640 tons Total.	Tons722,234	

The average of all cargo analyses for 1913 is as fol-Dried at 212° F. Analysis:

lows:

Mang. Alum. Lime Magnes. Sulph. Loss Iron Phos. Silica 55.05 .065 10.96

The ore in its natural state is as follows:

Moist Iron Phos. Silica 13.06 47.86 .056

FRANKLIN MINE.

Location: St. Louis County, Minnesota, Section 9, Township 58, Range 17.

Description: First opened up in 1893. The ore is soft, red and blue, Bessemer Hematite.

The ore is not crushed.

The mine is worked by the slicing system.

The greatest vertical depth is 200 feet. The ore is shipped via the D. & I. R. Railroad to Two Harbors, and thence by boat to lower lake ports.

Operating Company: Republic Iron & Steel Co., Youngstown, Ohio.

Manager: F. J. Webb.

Superintendent: Wm. White.

Sales Agents: Oglebay-Norton & Co., Cleveland, Ohio.

Yearly Shipments:

p	
1893— 46,617 tons	1904— 65,528 tons
1894—223,399 tons	1905—
1895—286,423 tons	1906— 66,935 tons
1896—231,086 tons	1907— 30,926 tons
1897— 30,128 tons	1908— 8,246 tons
1898-200,400 tons	1909— 51,393 tons
1899— 60,000 tons	1910— 31,614 tons
1900—168,524 tons	1911— 66,351 tons
1901— 39,299 tons	1912— 69,993 tons
1902—111,085 tons	1913— 51,760 tons
1903— 92,019 tons	
1905— 92,019 tons	

Total, Tons..........1,931,726

The average of all cargo analyses for 1913 is as fol-Analysis: Dried at 212° F. lows:

Phos. Silica Mang. Alum. Lime Magnes. Sulph. Iron 58.50 .034 11.50 .55 1.86 .10

The ore in its natural state is as follows:

Moist Iron Phos. Silica 6.50 54.70 .032 10.75

FRANTZ MINE.

Location: St. Louis County, Minnesota, Section 21, Township 58, Range 19.

Description: First opened up in 1904. The ore is soft, red, Non-Bessemer Hematite. Slicing system of mining was used. The ore was shipped via the Great Northern Railway to Allouez Bay and from there by boat to the lower lake ports.

Sales Agents: M. A. Hanna & Co., Cleveland, Ohio.

Yearly Shipments:

1906— 11,068 tons 1907— 907 tons 1904--- 62,884 tons 1905-70,210 tons 907 tons Total, Tons......145,069

GENOA MINE.

Location: St. Louis County, Minnesota, Section 34, Township 58, Range 17.

Description: First opened up in 1896. This mine ships three grades:

GROUP 1, soft, brown, Bessemer Hematite. GROUP 4, soft, yellow, Non-Bessemer Hematite.

GILWOOD, soft, yellowish-brown, silicious Bessemer Hem-

The ore is not crushed. The mine is worked by underground and open-pit methods. The greatest vertical depth is 319 feet. The ore is shipped via the D. & I. R. Railroad to Two Harbors, and thence by boat to lower lake ports.

Operating Company: The Oliver Iron Mining Co., Gilbert, Minn. General Manager: J. H. McLean.

General Superintendent: R. R. Trezona.

Yearly Shipments:

```
1896- 17,136 tons
                                                                    1905— 281,081 tons
1906— 179,468 tons
1897—309,514 tons
1897—309,514 tons
1898—279,677 tons
1899—276,559 tons
1900—253,651 tons
1901—332,022 tons
                                                                     1907— 108,610 tons
                                                                     1908-
                                                                     1909-
                                                                    1910- 283,299 tons
                                                                    1911— 923,477 tons
1912—1,315,840 tons
1913—1,141,673 tons
1902—399,719 tons
1903—303,700 tons
1904—244,150 tons
                       Total, Tons.......6,649,576
```

Analysis: See analyses of Groups 1, 4 and GILWOOD.

GILBERT MINE.

Location: St. Louis County, Minnesota, Section 26, Township 58, Range 17.

Description: First opened up in 1907. The mine ships three grades of ore:

GROUP 1, soft, brown, Bessemer Hematite.

GROUP 4, soft, yellow, Non-Bessemer Hematite.

GILWOOD, soft, gray, silicious Bessemer Hematite. The ore is not crushed. The mine is worked by underground and milling methods. The greatest vertical depth is 224 feet. The ore is shipped via the D. & I. R. Railroad to Two Harbors, and thence by boat to lower lake ports.

Operating Company: The Oliver Iron Mining Co., Gilbert, Minn.

General Manager: J. H. McLean.

General Superintendent: R. R. Trezona.

Yearly Shipments:

1907—100.178 tons	1911—
1908—336,927 tons	1912—135,622 tons
1909—783,683 tons	1913—104,538 tons
1910—110,788 tons	

Total, Tons......571,736

Analysis: See analyses of Groups 1, 4 and GILWOOD.

GLEN MINE.

Location: St. Louis County, Minnesota, Section 29, Township 58, Range 20.

Description: First opened up in 1902. The ore is a soft, yellow, Bessemer Hematite, and goes into Group 2. It is not crushed. The mine is worked by under-ground methods, the greatest vertical depth being 278 feet. The ore is shipped via the D. M. & N. Railway to Duluth, and thence by boat to lower lake ports.

Operating Company: The Oliver Iron Mining Co., Chisholm, Minn.

General Manager: J. H. McLean. General Superintendent: A. J. Sullivan.

Yearly Shipments:

1908—272,142 tons 1909—396,591 tons 1902— 23,875 tons 1903—171,705 tons 1904—280,412 tons 1905—287,835 tons 1906—279,424 tons 1910—286,051 tons 1911—113,512 tons 1912-1907—205,426 tons 1913-15 tons Total, Tons..........2,316,988

Analysis: See analysis of Group 2.

GRACE MINE.

Location: St. Louis County, near Chisholm, Minnesota, Sections 33 and 34, Township 58, Range 20.

Description: First opened up in 1911. Soft, yellow, Non-Bessemer, Hematite ore.

Underground caving system of mining is used. The ore is shipped via the Great Northern Railway to Superior, Wisconsin, and from there to the lower lake ports by boat.

Operating Company: The Inland Steel Company, Chicago, Ill.

Yearly Shipments:

1911— 1912— 60,641 tons Total, Tons.......182,751 1913-122,110 tons

The average of all cargo analyses for 1913 is as fol-Analysis:

lows: Dried at 212° F.

Mang. Alum. Lime Magnes. Sulph. Loss Phos. Silica Iron 56.81 5.72 .77

The ore in its natural state is as follows:

Moist Iron Phos. Silica 47.07 17.14 .061

GRAHAM MINE.

Location: St. Louis County, Minnesota, Section 21, Township 59, Range 14.

Description: First opened in 1912. The ore, which goes into Group 4, is a soft, yellowish-brown, Non-Bessemer Hematite, and is not crushed. The mine is worked by the openpit system. The ore is shipped via the D. & I. R. Railroad to Two Harbors, and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Mesaba, Minn.

Yearly Shipments:

1912-

1913-100,289 tons

Total, Tons......100,289

Analysis: See analysis of Group 4.

GRANT MINE.

Location: St. Louis County, Minnesota, Section 20, Township 58, Range 19.

Description: First opened up in 1902. The ore is soft, bluish, Non-Bessemer Hematite. Open-pit system of mining is used. Greatest vertical depth 126 feet.

The ore is shipped via the Great Northern Railway to Superior, and from there by boat to the lower lake ports.

Sales Agent: W. G. Pollock, Cleveland, Ohio.

Yearly Shipments:

1902— 51,946 tons	1908
1903— 18,928 tons	1909—
1904— 44,413 tons	1910—297,761 tons
1905— 49,227 tons	1911—350,475 tons
1906—	1912—399,848 tons
1907	1913—687.987 tons

Total, Tons..........1,800,585

The average of all cargo analyses for 1913 is as fol-Dried at 212° F. lows:

Mang. Alum. Lime Magnes. Sulph. Loss Iron Phos. Silica 60.55 .064 5.47

The ore in its natural state is as follows:

Moist Iron Phos. Silica 13.54 52.35 .055

GROUP NO. 1.

This Group is made up of ores from the following mines: Adams, Fayal, Genoa, Gilbert, Norman and Spencer.

The ore is a soft, brown, Bessemer Hematite.

The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 60.62 .040 .54 5.97 The ore in its natural state is as follows:

Moist Iron Phos. Silica 12.00 53.35 .035 5.25

GROUP NO. 2.

This Group is made up of ores from the following mines: Burt, Canisteo, Chisholm, Clark, Dale, Glen, Harold, Higgins, Hill, Holman, Hull-Rust, ludd, Leonard, Mace, Missabe Mountain, Mississippi, Monroe-Tener, Myers, North Uno, Sauntry-Alpena, Sellers, South Uno, Winifred. The ore is a soft, brown, Bessemer Hematite.

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss Iron .050 5.09 61.13 .56

The ore in its natural state is as follows:

Moist Iron Phos. Silica 11.36 54.18 .044

GROUP, NO. 3.

This Group is made up of ores from the following mines: Burt, Canisteo, Chisholm, Clark, Dale, Harold, Hartley-Burt, Hill, Holman, Hull-Rust, Leonard, Mace, Missabe Mountain, Mississippi, Monroe-Tener, North Uno, Sauntry-Alpena, Sellers, South Uno, Winifred.

The ore is a soft, brown, Non-Bessemer Hematite.

The average of all cargo analyses for 1913 is as fol-

Dried at 212° F. lows:

Mang. Alum. Lime Magnes. Sulph. Loss Phos. Silica Iron 53.14 .077 6.01 .86

The ore in its natural state is as follows:

Moist Iron Phos. Silica 13.04 50.55 .066

GROUP NO. 4.

This Group is made up of ores from the following mines: Adams, Fayal, Genoa, Gilbert, Graham, Norman, Spruce, Vivian.

The ore is a soft, brown, Non-Bessemer Hematite.

The average of all cargo analyses for 1913 is as fol-Analysis: Dried at 212° F. lows:

Mang. Alum. Lime Magnes. Sulph. Loss Iron Phos. Silica 55.22 7.98 .084

The ore in its natural state is as follows:

Moist Iron Phos. Silica 16.2**7** 46.23 .070

GROUP NO. 5.

This Group is made up of ores from the following mines: Burt, Canisteo, Hill, Holman, Hull-Rust, Judd, Myers, Sauntry-Alpena, Sellers, Winifred.

The ore is a soft, brown, Bessemer Hematite.

Analysis: The average of all cargo analyses for 1913 is as fol-Dried at 212° F. lows:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss .37 55.84 .045 12.81

The ore in its natural state is as follows:

Moist Iron Phos. Silica 10.57 49.94 .040 11.46

GROUP NO. 7.

This Group is made up of ores from the following mines: Burt, Canisteo, Chisholm, Clark, Hill, Holman, Hull-Rust, Judd, Leonard, Missabe Mountain, Mississippi, Monroe-Tener, North Uno, Sauntry-Alpena, Sellers, South Uno, Winifred. The ore is a soft, brown, Non-Bessemer, Hematite.

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 54.35 .079 11.78 .70

The ore in its natural state is as follows:

Moist Iron Phos. Silica 12.62 47.49 .069

GROUP NO. 8.

This Group is made up of ores from the following mines: Dale, Hill, Leonard, Mace, Mississippi, Monroe-Tener, South Uno.

The ore is a soft, brown, Bessemer Hematite.

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 57.52 .050 12.69 .12

The ore in its natural state is as follows:

Moist Iron Phos. Silica 8.96 52.36 .045

GROUP NO. 9.

This Group is made up of ores from the following mines: Burt, Clark, Hull-Rust, Missabe Mountain, Sauntry-Alpena, Sellers.

The ore is a soft, brown, Non-Bessemer Hematite.

The average of all cargo analyses for 1913 is as fol-Dried at 212° F. Analysis:

lows:

Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss Iron 57.70 .079 6.12 1.61

The ore in its natural state is as follows:

Moist Iron Phos. Silica 13.55 49.88 .068

HANNAH "A" MINE.

Location: St. Louis County, Minnesota, Sections 2 and 3, Township 58, Range 18.

Description: First opened up in 1909. The mine ships two grades of ore: PHILLIPS, soft, red, Non-Bessemer Hematite and SOUTHER, soft, red, Non-Bessemer, Manganese Hematite. It is said that the ore will be mined out this season. The mine is worked by the open-pit and scramming methods. The ore is shipped via the Great Northern Railway to Allouez Bay, and thence by boat to lower lake ports.

Operating Company: Consumers' Ore Co., Virginia, Minn.

Manager: James D. Ireland.

Superintendent: C. E. Hendrick.

Sales Agents: M. A. Hanna & Co., Cleveland, Ohio.

Yearly Shipments:—Hannah "A" and Hannah "B" mines.

1909—238,873 tons 1910—308,009 tons

1912-211,822 tons 1913-264,318 tons

1911- 26,252 tons

Total, Tons......1,049,274

Analysis: The average of all cargo analyses for 1913 is as fol-

lows: Dried at 212° F.

Phillips:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 54.84 1.44 2.39 .33 .072 6.13 .40 .027 4.40

Souther:

Phos. Silica Mang. Alum. Lime Magnes. Sulph. Iron Loss 56.85 .075 6.75 2.49 2.44 .30 .13 .022 5.62

The ore in its natural state is as follows:

Phillips:

Moist Iron Phos. 13.70 50.78 .062 5.29

Souther:

Iron Phos. Silica Moist 13.35 49.26 .065 5.85

HANNAH "B" MINE.

Location: St. Louis County, Minnesota, Section 2, Township 58, Range 18.

The ore in its natural state is as follows:

Hawkins:

Moist Iron Phos. Silica 11.17 51.75 .036 8.69 Hawkins Washed:

Moist Iron Phos. Silica 9.70 53.32 .036 7.34

HECTOR MINE (formerly Hale Mine.)

Location: St. Louis County, Minnesota, Section 1, Township 58, Range 16.

Description: First opened up in 1893. The ore was a soft, yellow, Non-Bessemer Hematite. Milling and underground mining systems used. Greatest vertical depth is 162 feet.

The ore was shipped via the Duluth & Iron Range Railroad to Two Harbors, and from there by boat to the lower lake ports.

Sales Agent: W. G. Pollock, Cleveland, Ohio.

Yearly Shipments:

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D	
1893— 3,616 tons	1904
1894— 24,167 tons	1905— 4,990 tons
1895— 31,004 tons	1906— 37,221 tons
1896— 70,006 tons	1907— 65,952 tons
1897— 13,728 tons	1908—
1898—	1909— 30,726 tons
1899— 18,807 tons	1910— 82,393 tons
1900— 32,901 tons	1911— 20,264 tons
1901— 30,929 tons	1912—
1902— 54,289 tons	1913
1903	

Total, Tons......521,353

HELMER MINE.

Location: St. Louis County, Minnesota, Section 14, Township 58, Range 19.

Description: First shipped ore in 1913. The ore is a Non-Bessemer Hematite, and the mine is worked by the open-pit system.

Operating Company: Swallow & Hopkins, 921 Rookery Bldg., Chicago, Ill.

Sales Agents: M. A. Hanna & Co., Cleveland, Ohio.

Yearly Shipments:

1913— 25,641 tons

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Helmer No. 1:

 Iron
 Phos.
 Silica
 Mang.
 Alum.
 Lime
 Magnes.
 Sulph.
 Loss

 60.00
 .072
 5.74
 .99
 1.08
 .31
 .22
 .005
 3.96

Helmer No. 2: Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 57.50 .080 5.74 2.50 1.90 .10 .16 .013 6.27 The ore in its natural state is as follows: Helmer No. 1: Moist Iron Phos. Silica 52.80 .063 12.00 Helmer No. 2: Moist Iron Phos. Silica 12.00 50.60 .070

HIGGINS MINE.

Location: St. Louis County, Minnesota, Section 4, Township 58, Range 17.

Description: First opened up in 1904. The ore is soft, dark gray, Bessemer Hematite. This ore goes into Group 2. Underground, milling and open-pit systems of mining are used. Greatest vertical depth 166 feet.

The ore is shipped via the Duluth, Missabe & Northern Railway to Duluth, and from there by boat to the lower lake ports.

The mine is operated by The Oliver Iron Mining Company.

Yearly Shipments:

Analysis: See analysis of Group 2.

HILL MINE.

Location: Itasca County, Minnesota, Section 17, Township 56, Range 23.

Description: First opened in 1910. This mine ships five grades of ore: GROUPS 2, 5 and 8, soft, brown, Bessemer Hematites and GROUPS 3 and 7, soft, brown, Non-Bessemer Hematites. The ore is not crushed. The mine is worked by the open-pit system. The greatest vertical depth is 225 feet. The ore is shipped via the Great Northern Railway to Superior, and thence by boat to lower lake ports.

Operating Company: The Oliver Iron Mining Co., Marble, Minn.

General Manager: J. H. McLean. General Superintendent: L. R. Salsich.

Yearly Shipments:

1910— 801,088 tons 1912—1 1911—1,550,568 tons 1913— Total, Tons.......4,396,529 1912—1,188,908 tons 1913— 855,965 tons

Analysis: See analyses of Groups 2, 3, 5, 7 and 8.

HOBART MINE.

Location: St. Louis County, Minnesota, Section 25, Township 58, Range 17.

Description: First opened up in 1906. The ore is a soft, red Non-Bessemer Hematite. Underground system of mining was used. Greatest vertical depth 248 feet.

This ore was shipped via the Duluth, Missabe & Northern Railway to Duluth and from there by boat to the lower lake ports.

Sales Agents: M. A. Hanna & Co., Cleveland, Ohio.

Yearly Shipments:

1906— 975 tons 1907— 7.339 tons Total, Tons......8,314

HOLLAND MINE.

Location: St. Louis County, Minnesota, Section 4, Township 58, Range 16.

Description: First opened up in 1910. Ore is a soft, brown, Bessemer Hematite. Underground method of mining is now used. The greatest vertical depth is 90 feet. The ore is shipped via the D. & I. R. Railroad to Two Harbors, and from there by boat to the lower lake ports.

Operating Company: Redwood Iron Mining Company, Duluth, Minnesota.

Manager: E. C. Leidel.

Superintendent: A. Faragher.

Sales Agents: Lake Erie Ore Co., Cleveland, Ohio.

Yearly Shipments:

1905-158,484 tons 1910-1906— 95,472 tons 1907— 16,908 tons 1911-1912-1908---1913-1909-

Total, Tons......270,864

The expected analysis for the season 1914 is as fol-Analysis:

Dried at 212° F. lows:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. 56.38 .045· 11.28 .85 1.58 .15 .27 .014

The ore in its natural state is as follows:

Moist Iron Phos. Silica 50.74 10.00 .040

HOLMAN MINE.

Location: Itasca County, Minnesota, Sections 21 and 22, Town-

ship 56, Range 24.

Description: First opened up in 1907. The mine ships four grades of ore: GROUPS 2 and 5, soft, dark-brown, Bessemer Hematite. GROUPS 3 and 7, soft, dark-brown, Non-Bessemer Hematite.

The ore is not crushed. The mine is worked by underground and open-pit methods. The greatest vertical depth is 207 feet. The ore is shipped via the D. M. & N. Railway to Duluth, and thence by boat to lower lake ports.

Operating Company: The Oliver Iron Mining Co., Taconite, Minn.

General Manager: J. H. McLean. General Superintendent: L. R. Salsich.

Yearly Shipments:

1907— 8,068 tons 1908— 1,682 tons 1909—391,157 tons 1911-779,889 tons 1912—919,699 tons 1913—751,422 tons

1910-413,873 tons

Total, Tons......3,265,718

Analysis: See analyses of Groups 2, 3, 5 and 7.

HUDSON MINE.

Location: St. Louis County, Minnesota, Section 4, Township 58, Range 15.

Description: First opened up in 1910. The ore is soft, yellow, Non-Bessemer Hematite.

The mine is worked by the open-pit system. The ore is shipped via the D. & I. R. Railroad to Two Harbors, and thence by boat to lower lake ports.

Operating Company: Syracuse Mining Co., Cleveland, Ohio.

Manager: C. H. Munger. Superintendent: W. P. Chinn.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

1910—168,553 tons 1911— 67,278 tons 1912—224,548 tons 1913—240,513 tons Total, Tons..........869,445

The average of all cargo analyses for 1913 is as fol-Analysis:

Dried at 212° F. lows:

Phos. Silica Iron Mang. Alum. Lime Magnes. Sulph. 59.20 5.77 .077 6.57 .66 1.84 .23 .18 .008

The ore in its natural state is as follows:

Moist Iron Phos. Silica 13.00 51.50 .067

HULL-RUST MINE.

St. Louis County, Minnesota, Sections 1 and 2, Location: Township 57, Range 21.

Description: First opened up in 1896. This mine ships five ores: GROUP 2, a soft, black, Bessemer Hematite.

GROUP 3, a soft, reddish-brown, Non-Bessemer Hematite.

GROUP 5, a soft, yellowish-red, Bessemer Hematite.

GROUP 7, a soft, red, Non-Bessemer Hematite.

GROUP 9, a soft, yellowish-red, Non-Bessemer Hematite. The ore is not crushed. The mine is an open-pit. The ore is shipped via the D. M. & N. Railway to Duluth, and thence by boat to lower lake ports.

Operating Company: The Oliver Iron Mining Co., Hibbing,

Minn.

General Manager: J. H. McLean. General Superintendent: W. J. West.

Yearly Shipments:

1906—1,690,311 tons 1907—2,900,493 tons 1910—3,189,975 tons 1911— 496,977 tons 1912—2,232,112 tons 1913—3,457,608 tons 1908-2,926,683 tons 1909—3,039,911 tons 1913—3 Total, Tons.......19,934,070

Analysis: See analyses of Groups 2, 3, 5, 7 and 9.

IROQUOIS MINE.

Location: St. Louis County, Minnesota, Section 10, Township

58, Range 18.

Description: First opened up in 1903. The ore is soft, redbrown Hematite. The mine is worked by underground and milling methods. The ore is shipped via the Great Northern and D. M. & N. Railways to Superior and Duluth, and thence by boat to lower lake ports.

Operating Company: The Rogers-Brown Ore Co.

Yearly Shipments:

Prior to 1909-725,257 tons 1911— 43,310 tons 1909—152,510 tons 1912— 80,000 tons 1910-231,824 tons 1913-111,159 tons

JENNINGS MINE.

Location: St. Louis County, Minnesota, Section 14, Township

58, Range 19.

Description: First opened up in 1906. The ore is a soft, red, Non-Bessemer Hematite. Open-pit system of mining was The ore was shipped via the Duluth & Iron Range Railroad to Two Harbors and from there by boat to the lower lake ports.

Sales Agents: M. A. Hanna & Company, Cleveland, Ohio.

Yearly Shipments:

1908— 18,313 tons 1909— 10,477 tons

JORDAN MINE.

Location: St. Louis County, Minnesota, Section 22, Township 58, Range 20.

Description: First opened up in 1902, now idle. Soft, red, Non-Bessemer Hematite. Underground system of mining was used. Greatest vertical depth 193 feet.

The ore was shipped via the Great Northern Railway to Allouez Bay and from there by boat to the lower lake ports.

Sales Agents: M. A. Hanna & Company, Cleveland, Ohio.

Yearly Shipments:

ombinence.	
1902—147,931 tons	1907— 61,996 tons
1903—190,024 tons	1908—118,529 tons
1904— 97,474 tons	1909— 12,754 tons
1905—185,854 tons	1910— 20,314 tons
1906—110,768 tons	
Total,	Tons945,644

JUDD MINE.

Location: St. Louis County, Minnesota, Section 21, Township 56, Range 24.

Description: First opened up in 1913. The ore, which goes into Groups 2, 5 and 7, is soft, brown, Bessemer and Non-Bessemer Hematite. The ore is not crushed. The mine is worked by the open-pit system. The ore is shipped via the D. M. & N. Railway to Duluth, and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Taconite, Minn.

General Manager: J. H. McLean.

General Superintendent: L. R. Salsich.

Yearly Shipments:

1913—103,495 tons

Analysis: See analyses of Groups 2, 5 and 7.

KINNEY MINE.

Location: St. Louis County, Minnesota, Section 14, Township

58, Range 19.

Description: First opened up in 1903. The ore, KINNEY No's. 1, 2, 3 and 4, is soft, red, Non-Bessemer Hematite, and is not crushed. The mine is worked by steam-shovel, the greatest vertical depth being 149 feet. The ore is shipped via the Great Northern Railway to Allouez Bay, and thence by boat to lower lake ports.

Operating Company: Republic Iron & Steel Co., Youngstown, Ohio.

Sales Agents: M. A. Hanna & Co., Cleveland, Ohio.

Yearly Shipments:

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    1903— 32,352 tons
    1909—287,421 tons

    1904— 6,225 tons
    1910—401,920 tons

    1905— 89,161 tons
    1911—455,836 tons

    1906— 57,697 tons
    1912—530,080 tons

    1907—145,989 tons
    1913—396,394 tons

    1908—176,510 tons
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Total, Tons......2,573,579

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Kinney No. 1: Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss Iron 59.30 .070 5.90 .73 3.30 .14 .023 4.64 .13 Kinney No. 2: Phos. Silica Mang. Alum. Lime Magnes. Sulph. Iron Loss 58.00 .080 6.00 1.00 3.70 .17 .14 .030 5.60

Kinney No. 3: Phos. Silica Alum. Iron Mang. Lime Magnes. Sulph. Loss 56.00 .85 .080 **7.50** 4.60 .21 .23 .036 6.11 Kinney No. 4:

Phos. Silica Mang. Alum. Iron Lime Magnes. Sulph. Loss 53.50 .071 8.40 1.67 7.53 .21 .44 .045 5.27 The ore in its natural state is as follows:

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Kinney No. 1:

Moist Iron Phos. Silica 13.30 51.41 .061 5.11 Kinney No. 2:

Moist Iron Phos. Silica 13.75 50.03 .069 5.17

Kinney No. 3:
Moist Iron Phos. Silica

14.50 47.88 .068 6.41 **Kinney No. 4:**

Moist Iron Phos. Silica 15.00 45.48 .060 7.14

KNOX MINE.

Location: St. Louis County, Minnesota, S. E. 1/4 of S. W. 1/4, Section 19, Township 59, Range 14.

Description: First opened up in 1909. The ore is a soft, red, Non-Bessemer Hematite. Caving system of mining used. Greatest vertical depth 117 feet.

The ore is shipped via the Duluth & Iron Range Railroad to Two Harbors and from there by boat to the lower lake ports. Mine is now idle.

Yearly Shipments:

1909— 7,464 tons	1912—101,169 tons
1910— 50,942 tons	1913— 20,123 tons
1911—	

Total, Tons179,698

LABELLE MINE.

Location: St. Louis County, Minnesota, Section 24, Township

58, Range 17 West.

Description: First opened up in 1901. The ore is a soft, brown, Bessemer Hematite. Underground method of mining is now used. The greatest vertical depth is 220 feet. The ore is shipped via the Duluth & Iron Range Railroad to Two Harbors, and from there by boat to the lower lake ports.

Operating Company: Pitt Iron Mining Co., Steubenville, Ohio. Superintendent: C. E. Moore.

Sales Agents: LaBelle Iron Works, Steubenville, Ohio.

Yearly Shipments:

omphinemes.	
1902— 70,753 tons	1908— 51,638 tons
1903— 48,298 tons	1909— 27,216 tons
1904— 89,554 tons	1910— 20,349 tons
1905— 78,597 tons	1911— 14,743 tons
1906— 50,466 tons	1912— 14,896 tons
1907— 56,146 tons	1913— 10,038 tons
Total.	Tons532.694

LARKIN MINE (formerly Tesora Mine).

Location: St. Louis County, Minnesota, N. E. 1/4 of N. E. 1/4,

Section 4, Township 58, Range 17.

Description: First opened up in 1906. The ore is a soft, brown, Bessemer Hematite. Caving system of mining was used. Greatest vertical depth about 90 feet. The mine is idle. The ore is shipped via the Duluth & Iron Range Railroad to Two Harbors and from there by boat to the lower lake ports.

Sales Agents: M. A. Hanna & Company, Cleveland, Ohio.

Yearly Shipments:

1906— 12,001 tons	1910— 21,700 tons
1907— 22,040 tons	1911— 2,668 tons
1908— 14,030 tons	1912— 16,542 tons
1909-46,651 tons	1913— 69,200 tons
Tota	l. Tons204.832

LA RUE MINE.

Location: Itasca County, Minnesota, Sections 29 and 32, Township 57, Range 22 West.

Description: First opened up in 1903. Two ores are shipped from this mine: LA RUE, a soft, red, Bessemer Hematite; and NASHWAUK, a soft, red, Non-Bessemer Hematite. Open-pit steam shovel system of mining is used. The ore is shipped via the Great Northern Railway to Allouez Bay, and from there to the lower lake ports by boat.

Operating Company: La Rue Mining Company. Virginia, Minn.

Manager: James D. Ireland. Superintendent: C. E. Hendrick.

Sales Agents: M. A. Hanna & Company, Cleveland, Ohio.

Yearly Shipments:

 1903—53,335 tons
 1909—365,543 tons

 1904—105,170 tons
 1910—128,658 tons

 1905—197,192 tons
 1911—30,141 tons

 1906—175,670 tons
 1912—155,552 tons

 1907—301,522 tons
 1913—172,332 tons

 1908—79,313 tons

Total, Tons......1,764,427

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

La Rue:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 57.40 .029 11.62 .38 1.55 .31 .16 .011 3.82

The ore in its natural state is as follows: Moist Iron Phos. Silica

9 29 52.07 .026 10.54

Nashwauk:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 56.87 .081 11.08 .76 1.85 .24 .18 .009 3.46 The ore in its natural state is as follows:

Moist Iron Phos. Silica

10.00 51.18 .073 9.97

The expected analysis for the season of 1914 is as follows: Dried at 212° F.

LAURA MINE.

Location: St. Louis County, Hibbing, Minnesota, Section 31, Township 58, Range 20.

Description: First opened up in 1894. Ore is a soft, red, Non-Bessemer Hematite. Underground caving system of mining is used. The ore is shipped via the Great Northern Railway

to Superior, Wisconsin, and from there to the lower lake ports by boat.

Operating Company: Inland Steel Company, Chicago, Illinois.

Yearly Shipments:

1902— 16,453 tons	1908—176,725	tons
1903— 79.286 tons	1909—178,110	tons
1904— 3.778 tons	1910—189,046	tons
1905— 27,207 tons	1911—238,824	tons
1906—138,001 tons	1912—270,411	tons
1907—149,410 tons	1913—184,530	tons
	Tons1.651.781	

The average of all cargo analyses for 1913 is as fol-Analysis:

Dried at 212° F. lows:

Mang. Alum. Lime Magnes. Sulph. Loss Iron Phos. Silica

53.59 .079 12.86 1.16 2.33

The ore in its natural state is as follows:

Moist Iron Phos. Silica 11.25 12.55 48.86 .069

LEETONIA MINE.

Location: St. Louis County, Minnesota, Section 10, Township

57, Range 21.

Description: First opened up in 1902. The ore is a soft, yellow, Non-Bessemer Hematite. Underground and open-pit systems of mining are used. Greatest vertical depth 100 feet. The ore is shipped via the Great Northern Railway to Superior and from there by boat to the lower lake ports.

Sales Agent: W. G. Pollock, Cleveland, Ohio.

Yearly Shipments:

1902— 28,784 tons	1908—289,490 to	ons
1903—200,163 tons	1909—553,162 to	ons
1904—228,536 tons	1910—615,396 to	ons
1905—352,004 tons	1911—353,063 to	ons
1906—308,989 tons	1912—368,301 to	
1907—301,368 tons	1913—501,248 to	ons
Total.	Tons4.100.504	

The average of all cargo analyses for 1913 is as fol-Dried at 212° F.
Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss

lows:

Iron 59.14

.056

The ore in its natural state is as follows:

Moist Iron Phos. Silica 11.34 52.43 .049 6.09

LEONARD MINE.

St. Louis County, Minnesota, Sections 28 and 29, Township 58, Range 20.

Description: First opened up in 1903. The mine ships four grades of ore: GROUPS 2 and 8, soft, brown, Bessemer Hematites; GROUP 3, a soft, yellow, Non-Bessemer Hematite; and GROUP 7, a soft, red, Non-Bessemer Hematite. The ore is not crushed. The mine is worked by underground and open-pit methods, the greatest vertical depth being 253 feet. The ore is shipped via the Great Northern Railway to Superior, and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Chisholm, Minn.

General Manager: J. H. McLean.

General Superintendent: A. J. Sullivan.

Yearly Shipments:

1903—	10,591	tons	1909— 6,8	357 tons	į
1904	151,952	tons	1910— 987,		
1905—	297,011	tons	1911—1,293,	163 tons	š
1906—	254,368	tons	1912—2,198,	119 tons	š
1907—	137,316	tons	1913—2,252,	367 tons	j
1000					

Total, Tons...........7,590,954

Analysis: See analyses of Groups 2, 3, 7 and 8.

LILEY MINE.

Location: St. Louis County, Minnesota, Section 16, Township 58, Range 17.

Description: First opened up in 1907. Ore from this mine is called ALBERTA. It is a soft, blue-black, Bessemer and Non-Bessemer Hematite. Caving system of mining was used. Greatest vertical depth 110 feet.

The ore was shipped via the Duluth & Iron Range Railroad to Two Harbors and from there by boat to the lower lake

ports.

Sales Agents: M. A. Hanna & Company, Cleveland, Ohio.

Yearly Shipments:

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1907— 31,032 tons 1909—
1908— 51,143 tons 1910— 25,404 tons
Total, Tons.......107,579
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LINCOLN MINE.

Location: St. Louis County, Minnesota, Sections 4 and 5, Township 58, Range 17.

Description: First opened up in 1902. This mine ships DOUG-LAS ore, a soft, brown, Bessemer Hematite. Slicing system of mining is used. Greatest vertical depth is 237 feet.

The ore is shipped via the Duluth, Missabe & Northern Railway to Duluth and from there by boat to the lower lake ports.

Sales Agent: W. G. Pollock, Cleveland, Ohio.

Yearly Shipments:

1902— 87,908 tons	1908—379,219	tons
1903—279,399 tons	1909—303,066	
1904—153,822 tons	1910—318,912	tons
1905—275,777 tons	1911—208,556	tons
1906—367,192 tons	1912—173,979	tons
1907—297,870 tons	1913—215,957	tons
Total,	Tons3,061,657	

The average of all cargo analyses for 1913 is as fol-

Dried at 212° F. lows:

Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss Iron

59.16 .028 10.45

The ore in its natural state is as follows:

Moist Iron Phos. Silica 6.96 55.04 .026

LONGYEAR MINE.

Location: St. Louis County, Minnesota, Sections 5 and 6, Township 57, Range 20.

Description: First opened up in 1902. The ore is a soft, Non-Bessemer Hematite. Underground system of mining is used. Greatest vertical depth 100 feet.

The ore is shipped via the Great Northern Railway to Superior and from there by boat to the lower lake ports.

Sales Agent: W. G. Pollock, Cleveland, Ohio.

Yearly Shipments:

1902— 22,788 tons	1911—
1903— 81,604 tons	1912—
1904— 221 tons	1913— 11,799 tons
1905— 16,778 tons	•
Total,	Tons133,190

Analysis: The average of all cargo analyses for 1913 is as fol-

Dried at 212° F. lows:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 53.62 10.33

.106

The ore in its natural state is as follows:

Moist Iron Phos. Silica 13.64 46.31 .091

MACE MINE.

Location: St. Louis County, Minnesota, Section 7, Township 57, Range 21.

Description: First opened up in 1910. This mine ships three grades of ore: GROUP 2, a soft, brownish-black, Bessemer Hematite; GROUP 3, a soft, yellowish-brown, Non-Bes-

semer Hematite; and GROUP 8, a soft, yellowish-brown, Bessemer Hematite. The ore is not crushed. The mine is worked by underground and milling systems, the greatest vertical depth being 114 feet. The ore is shipped via the Great Northern Railway to Superior, and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Hibbing, Minn.

General Manager: J. H. McLean. General Superintendent: W. J. West.

Yearly Shipments:

1912—136,524 tons 1913—140,953 tons

Analysis: See analyses of Groups 2, 3 and 8.

MADERIA MINE.

Location: St. Louis County, Minnesota, Section 36, Township 58, Range 21.

Description: First opened up in 1910. The ore is a soft, darkbrown Bessemer Hematite. Underground system of mining is used. The greatest vertical depth is 100 feet.

The ore is shipped via the Great Northern Railway to Allouez

Bay and from there by boat to the lower lake ports. Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

1910— 83,922 tons 1911— 56,075 tons

1912— 46,494 tons 1913— 2,805 tons

Total, Tons......189,296

MADRID MINE.

Location: St. Louis County, Minnesota, Section 8, Township 58, Range 17.

Description: First opened up in 1912. The ore is a hard and soft, brown, Bessemer Hematite, and is not crushed. The mine is worked by the caving system, the greatest vertical depth being 132 feet. The ore is shipped via the D. M. & N. Railway to Duluth, and thence by boat to lower lake ports.

Operating Company: Eureka Ore Co., Virginia, Minn.

Manager: H. O. Johnson.

Superintendent: Norman Deuwett.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

1913- 86,053 tons 1912— 26,906 tons Total, Tons......112,959

Analysis: The expected analysis for the season of 1914 is as fol-

Dried at 212° F. lows:

Mang. Alum. Lime Magnes. Sulph. Phos. Silica Loss Iron 57.01 13.30 1.32 .019 .60 .31

The ore in its natural state is as follows:

Moist Iron Phos. Silica 7.50 52.73 .017 12.30

MAHONING MINE.

Location: St. Louis County, Minnesota, Sections 1 and 2, Township 57, Range 21 West.

Description: First opened up in 1895. This mine ships four grades of ore: MAHONING, a soft, blue, Bessemer Hematite; BEAVER, a soft, brown, Non-Bessemer Hematite; CLARION, a soft, brown, Non-Bessemer Hematite; and STOCK BEAVER, a soft, red, Non-Bessemer Hematite. is not crushed. The mine is worked by the open-pit system, the greatest vertical depth being 200 feet. The ore is shipped via the Great Northern Railway to Allouez Bay, and thence by boat to lower lake ports.

Operating Company: Mahoning Ore & Steel Co., Hibbing, Minn.

Manager: W. C. Agnew.

Superintendent: J. C. Agnew. Sales Agents: M. A. Hanna & Co., Cleveland, Ohio.

Yearly Shipments:

D		
1895— 117,884 tons	1904— 706,325	tons
1896— 167,245 tons		
1897— 519,892 tons	1906—1,274,232	tons
1898— 520,751 tons	1907—1,564,336	
1899— 750,341 tons	1908— 611,592	
1900— 911,021 tons	1909—1,561,893	
1901— 765,872 tons	1911—1,011,945	
1902—1,038,645 tons		
1903-1,009,446 tons		tons
Total,	Tons18,092,871	

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Mahoning	z:							
Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sulph.	Loss
63.83	.048	2.61	.31	1.05	.11	.12	.026	4.80
Beaver:								
Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sulph.	Loss
61.27	.085	3.30	.37	1.93	.20	.10	.013	5.75
Clarion:								
Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sulph.	Loss
54.49	.083	6.40	3.24	2.87	.10	.23	.010	7.37
Stock Bea	aver:							
Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sulph.	Loss
56.98	.083	7.60	.45	4.21	.14	.10	.012	4.75

The ore in its natural state is as follows:

```
Mahoning:
  Moist
         Iron Phos.
                        Silica
  10.69
          57.01
                 .043
                          2.33
Beaver:
  Moist
          Iron
                Phos.
                        Silica
  12.40
          53.67
                 .074
Clarion:
                Phos.
                        Silica
  Moist
          Iron
  12.78
          47.53
                  .072
                          5.58
Stock Beaver:
                        Silica
  Moist Iron
                Phos.
  15.18
          48.33
                 .070
                          6.45
```

MALTA MINE.

Location: St. Louis County, Minnesota, Section 35, Township 58, Range 17.

Description: First opened up in 1899. The ore is a soft, red, and dark-blue, Bessemer Hematite, and is not crushed. The mine is worked by open-pit and underground methods, the greatest vertical depth being 248 feet. The ore is shipped via the D. & I. R. Railroad to Two Harbors, and thence by boat to lower lake ports.

Operating Company: Malta Iron Co., Cleveland, Ohio. Manager: C. H. Munger. Superintendent: W. P. Chinn.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

```
1899— 28,615 tons
                                                  1907- 82,062 tons
1900— 65,346 tons
                                                  1908-93,072 tons
1901—126,299 tons
1902—222,640 tons
1903—11,695 tons
                                                  1909- 92,356 tons
                                                 1910— 72,035 tons
1911— 10,608 tons
1904— 66,641 tons
                                                  1912— 2.817 tons
1905—139,853 tons
1906—115,763 tons
                                                  1913— 93,632 tons
```

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss Iron .25 57.40 .025 13.86 .38 .67 .19 .006 2.47 The ore in its natural state is as follows:

Moist Iron Phos. Silica 8.00 52.81 .023 12.75

MARISKA MINE.

Location: St. Louis County, Minnesota, Section 24, Township 58, Range 17.

Description: First opened up in 1907. The ore is a soft, red, Non-Bessemer Hematite, and is not crushed. The mine is worked by the slicing system, the greatest vertical depth being 208 feet. The ore is shipped via the D. & I. R. Railroad to Two Harbors, and thence by boat to lower lake ports.

Operating Company: Republic Iron & Steel Co., Youngstown, Ohio.

Manager: F. J. Webb.

Superintendent: D. T. Caine.

Sales Agents: M. A. Hanna & Co., Cleveland, Ohio.

Yearly Shipments:

1907— 137 tons 1908— 30,226 tons 1911— 2,367 tons 1912— 1909— 77,690 tons 1913---1910- 23,265 tons

Total, Tons......133,685

Analysis: The expected analysis for 1914 is as follows: Dried at 212° F.

Lime Magnes. Sulph. Iron Phos. Silica Mang. Alum. Loss 52.91 .049 19.37 .39 1.70 .25 .20 2.25 The ore in its natural state is as follows:

Moist Iron Phos. Silica 12.00 46.56 .043 17.05

McKINLEY MINE.

Location: St. Louis County, Minnesota, Section 8, Township 58, Range 16.

Description: First opened up in 1907. The ore is Bessemer and Non-Bessemer Hematite.

The mine was operated by The Oliver Iron Mining Company.

Yearly Shipments:

1907— 17,705 tons 1909-89,981 tons 1907— 17,705 tons 1908— 1,399 tons Total, Tons.......109,086 1910-

MEADOW MINE.

Location: St. Louis County, Minnesota, Section 3, Township 58, Range 15.

Description: First opened up in 1910. The ore is a soft, red, Non-Bessemer Hematite. The caving and slicing systems of mining are used. The greatest vertical depth is 250 feet. The ore is shipped via the Duluth & Iron Range Railroad to

Two Harbors and from there by boat to the lower lake ports. Sales Agent: W. G. Pollock, Cleveland, Ohio.

Yearly Shipments:

1912— 10,629 tons 1913— 25,106 tons 1910- 4,392 tons 1911-Total, Tons.......40,127

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 55.35 .078 10.78

The ore in its natural state is as follows:

Moist Iron Phos. Silica 14.51 47.32 .066 9.21

MILLER MINE.

Location: St. Louis County, Minnesota, Section 4, Township

58, Range 15 West.

Description: First opened up in 1904. The ore is a soft, brown, Non-Bessemer Hematite. Shaft system of mining is used. The ore is shipped via the Duluth & Iron Range Railroad to Two Harbors, and from there by boat to the lower lake ports.

Operating Company: Pitt Iron Mining Company, Steubenville, Ohio.

Superintendent: C. E. Moore.

Sales Agents: LaBelle Iron Works, Steubenville, Ohio.

Yearly Shipments:

 1904—
 1909—277,119 tons

 1905—118,520 tons
 1910—216,263 tons

 1906—234,071 tons
 1911—282,636 tons

 1907—279,453 tons
 1912—301,518 tons

 1908—224,321 tons
 1913—344,547 tons

 Total, Tons
 2,278,448

Analysis: The average of all cargo analyses for 1913 is as fol-

lows: Dried at 212° F.

 Iron
 Phos. Silica
 Mang. Alum.
 Lime Magnes.
 Sulph. Loss

 56.69
 .082
 7.16
 .77
 4.00
 .10
 .08
 .067

The ore in its natural state is as follows:

Moist Iron Phos. Silica 12.07 49.85 .072 6.29

MINORCA MINE.

Location: St. Louis County, Minnesota, Sections 4 and 5, Town-

ship 58, Range 17.

Description: First opened up in 1902. The mine ships two grades of ore: MINORCA, a soft, red, Bessemer Hematite, and MINORCA REX, a soft, red, Non-Bessemer Hematite. The ore is not crushed. The mine is worked by the slicing system, the greatest vertical depth being 90 feet. The ore is shipped via the D. & I. R. Railroad to Two Harbors, and thence by boat to lower lake ports.

Operating Company: Hobart Iron Co., Cleveland, Ohio.

Manager: C. H. Munger. Superintendent: W. P. Chinn.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

1902— 35,499 tons	1908— 80,330	tons
1903—115,886 tons	1909—119,154	tons
1904—121,739 tons	1910— 66,511	tons
1905—117,653 tons	1911— 67,942	tons
1906—155,541 tons	1912— 37,235	
1907—154,661 tons	1913— 90,837	tons
Total.	Tons1.162.988	

Analysis: The expected analysis for 1913 is as follows: Dried at 212° F.

Minorca:

lron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	·Sulph.	Loss
56.50	.033	13.00	1.06	.61	.24	.20	.007	2.73
Minorc	a-Rex:							
Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sulph.	Loss
54.46	.057	13.00	3.00	.61	.24	.20	.007	2.73
The	ore in i	ts natui	al state	is as	follows	3:		
Minoro								

M oıst	lron	Phos.	Silica
7.00	52.55	.031	12.09
Minorca-	Rex:		
Moist		Phos.	Silica
7.25	50.51	.053	12.06

MINNEWAS MINE.

Location: St. Louis County, Minnesota, Section 16, Township 58, Range 17.

Description: First opened up in 1893. The ore is Bessemer and Non-Bessemer Hematite.

The mine was operated by The Oliver Iron Mining Company.

Yearly Shipments:

1893— 1	13,858	tons	1911—	295	tons
1894—	2,140	tons	1912—		
1898—	525	tons	1913—		
1910	963	tons			
		Total,	Tons17,781		

MISSABE MOUNTAIN MINE.

Location: St. Louis County, Minnesota, Section 8, Township 58, Range 17.

Description: First opened up in 1893. The mine ships four grades of ore: GROUP 2, a soft, black, Bessemer Hematite; and GROUPS 3, 7 and 9, all soft, brownish-black, Non-Bessemer Hematites. The ore is not crushed. The mine is worked by the open-pit system. The ore is shipped via the D. M. & N. Railway to Duluth, and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Virginia, Minn.

General Manager: J. H. McLean.

General Superintendent: M. H. Godfrey.

Yearly Shipments:

1910— 7,226 tons

1912— 5,592 tons

1911-1913—321,835 tons Total, Tons......334,649

Analysis: See analyses of Groups 2, 3, 7 and 9.

MISSISSIPPI MINE.

Location: Itasca County, Minnesota, Sections 14 and 23, Township 57, Range 22.

Description: First opened up in 1910. This mine ships four grades of ore: GROUP 2, a soft, brown, Bessemer Hematite; GROUPS 3 and 7, both soft, reddish-brown, Non-Bessemer Hematites; and GROUP 8, a soft, reddish-brown, Bessemer Hematite. The ore is not crushed. The mine is worked by underground methods, the greatest vertical depth being 133 feet. The ore is shipped via the Great Northern Railway to Superior, and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Hibbing, Minn. General Manager: J. H. McLean.

General Superintendent: W. J. West.

Yearly Shipments:

1910— 36,581 tons 1911—328,601 tons

1912-274,729 tons 1913—122,972 tons

Total, Tons..........762,883

Analysis: See analyses of Groups 2, 3, 7 and 8.

MOHAWK MINE.

Location: St. Louis County, Minnesota, Section 4, Township 58, Range 15.

Description: First opened up in 1906. The ore is a soft, red, Non-Bessemer Hematite, and is not crushed. The mine is worked by the slicing system, the greatest vertical depth being 274 feet. The ore is shipped via the D. & I. R. Railroad to Two Harbors, and thence by boat to lower lake ports.

Operating Company: Mohawk Mining Co., Cleveland, Ohio.

Manager: C. H. Munger.

Superintendent: W. P. Chinn.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 56.50 .080 8.72 .78 2.38 .27 .22 .010 6.60

The ore in its natural state is as follows:

Moist Iron Phos. Silica 13.00 49.16 .069 7.58

MONICA MINE.

Location: St. Louis County, Minnesota, Section 9, Township 58, Range 16.

Description: First opened up in 1909. The ore is a soft, red Bessemer Hematite. The slicing system of mining is used. The greatest vertical depth is 180 feet.

The ore is shipped via the Duluth & Iron Range Railroad to Two Harbors and from there by boat to the lower lake ports.

Operating Company: Republic Iron & Steel Co., Youngstown, Ohio.

Manager: F. J. Webb.

Superintendent: P. S. Kurtzman.

Sales Agents: Oglebay, Norton & Co., Cleveland, Ohio.

Yearly Shipments:

1909— 7,614 tons 1912— 92,754 tons 1910— 69,503 tons 1911—112,952 tons

Total, Tons......344,855°

Analysis: The average of all cargo analyses for 1913 is as fol-

lows: Dried at 212° F.

 Iron
 Phos. Silica
 Mang. Alum. Lime
 Magnes. Sulph. Loss

 55.50
 .035
 17.00
 .45
 1.25
 .16
 .09
 .008
 1.52

The ore in its natural state is as follows:

Moist Iron Phos. Silica 9.00 50.51 .032 15.47

MONROE-TENER MINE.

Location: St. Louis County, Minnesota, Section 28, Township 58, Range 20.

Description: First opened up in 1905. This mine ships four grades of ore: GROUP 2, a soft, brown, Bessemer Hematite;

GROUPS 3 and 7, both soft, brownish-red, Non-Bessemer Hematites; and GROUP 8, a soft, brown, Bessemer Hematite. The ore is not crushed. The mine is worked by underground methods, the greatest vertical depth being 298 feet. The ore is shipped via the Great Northern Railway to Superior, and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Chisholm, Minn.

General Manager: J. H. McLean.

General Superintendent: A. J. Sullivan.

Yearly Shipments:

```
1909—147,521 tons

1905—13,730 tons

1906—310,839 tons

1907—156,809 tons

1912—

1908—

1913—485,847 tons
```

Total, Tons........1,114,746

Analysis: See analyses of Groups 2, 3, 7 and 8.

MORRIS MINE.

Location: St. Louis County, Minnesota, Sections 31 and 32,

Township 58, Range 20.

Description: First opened up in 1905. The ore is a soft, yellowish-red, Non-Bessemer, and a yellow Bessemer. Open-pit system of mining is used.

The ore is shipped via the Duluth, Missabe & Northern Railway to Duluth and from there by boat to the lower lake ports. The mine is operated by The Oliver Iron Mining Company.

Yearly Shipments:

1905—1,070,937 to	ns	1910-1,	364,673	tons
1906—1,809,743 to	ns	1911—	40,481	tons
1907—2,076,388 to		1912—	395	tons
1908— 528,154 to	ns	1913—		
1909—1,831,187 to	ns			
Tota	l, Tons8,	721,958		

MORROW MINE.

Location: St. Louis County, Minnesota, Section 4, Township

57, Range 17.

Description: First opened up in 1913. The ore is a soft, brown, Non-Bessemer Hematite, and is not crushed. The mine is worked by steam-shovel, the greatest vertical depth being 185 feet. The ore is shipped via the D. & I. R. Railroad to Two Harbors, and thence by boat to lower lake ports.

Operating Company: Pearson Mining Co., Duluth, Minn.

Manager: R. M. Sellwood.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

1913— 91,512 tons

The average of all cargo analyses for 1913 is as fol-Analysis: lows: Dried at 212° F. Phos. Silica Mang. Alum. Lime Magnes. Sulph. Iron .061 1.08 1.74 57.50 6.58 .29 .24 .012 The ore in its natural state is as follows:

Moist Iron Phos. Silica 13.00 50.03 .053 5.72

MOUNTAIN IRON MINE (Formerly Aetna Mine).

Location: St. Louis County, Minnesota, Section 3, Township 58, Range 18.

Description: First opened up in 1892. The ore is Bessemer and Non-Bessemer Hematite. The open-pit system of mining was used.

This mine was operated by The Oliver Iron Mining Co.

Yearly Shipments:

1902—1,617,772 tons		
1903—1,348,714 tons		
1904—1,168,855 tons		
1905—2,495,089 tons		
1906—2,563,111 tons		
1907—1,973,519 tons		
1908— 206,698 tons		
1909—		
1910—		
Total, Tons17,198,871		

MYERS MINE.

Location: St. Louis County, Minnesota, Section 22, Township 58, Range 20.

Description: First opened up in 1905. The ore is a dark, brown, Bessemer Hematite and goes into Groups 2 and 5. Underground system of mining is used. Greatest vertical depth is 206 feet. The ore is shipped via the Duluth, Messabe & Northern Railway to Duluth and from there by boat to the lower lake ports.

Operating Company: Oliver Iron Mining Co., Chisholm, Minn. General Manager: J. H. McLean.

General Superintendent: A. J. Sullivan.

Yearly Shipments:

ompinents.	
1905—188,568 tons	1910—131,440 tons
1906—228,451 tons	1911— 93,203 tons
1907—153,770 tons	1912—101,558 tons
1908—150,249 tons	1913— 39.951 tons
1909—193,698 tons	, , , , , , , , , , , , , , , , , , , ,

Total, Tons......280,888

Analysis: See analyses of Groups 2 and 5.

NASSAU MINE.

Location: St. Louis County, Minnesota, Section 5, Township 57, Range 20.

Description: First opened up in 1907. The ore is soft, red, Non-Bessemer Hematite. Underground system of mining was used.

Greatest vertical depth is 180 feet.

The ore was shipped via the Duluth, Messabe & Northern and the Great Northern Railways to Duluth and Superior and from these docks by boat to the lower lake ports.

Sales Agent: W. G. Pollock, Cleveland, Ohio.

Yearly Shipments:

1907— 19,172 tons 1909— 11,940 tons 1908— 1910— 39 tons Total, Tons......31,151

NORMAN MINE.

Location: St. Louis County, Minnesota, Section 9, Township 58, Range 17.

Description: Re-opened in 1907. The mine ships three grades of ore: GROUP 1, soft, dark-brown, Bessemer Hematite; GROUP 4, a soft, reddish-yellow, Non-Bessemer Hematite; and GILWOOD, a soft, blue-gray, silicious Bessemer Hematite. The ore is not crushed. The mine is worked by underground methods, the greatest vertical depth being 341 feet. The ore is shipped via the D. & I. R. Railroad to Two Harbors, and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Virginia, Minn. General Manager: J. H. McLean.

General Superintendent: R. J. Mitchell.

Yearly Shipments:

1894— 38,999 tons 1898—110,141 tons 1895— 93,392 tons 1912—614,022 tons 1896— 77,523 tons 1913—276,732 tons 1897—101,077 tons

Total, Tons......1,311,866

Analysis: See analyses of Groups 1 and 4 and GILWOOD.

NORTH UNO MINE.

Location: St. Louis County, Minnesota, Section 2, Township 57, Range 21.

Description: First opened up in 1910. This mine ships three grades of ore: GROUP 2, a soft, brownish-black, Bessemer Hematite; GROUP 3, a soft, yellowish-red, Non-Bessemer

Hematite; and GROUP 7, a soft, yellowish-brown, Non-Bessemer Hematite. The ore is not crushed. The mine is worked by the open-pit method. The ore is shipped via the Great Northern Railway to Superior, and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Hibbing, Minn.

General Manager: J. H. McLean. General Superintendent: W. J. West.

Yearly Shipments:

1910-341,939 tons 1912—545,033 tons 1913—381,632 tons 1911—479,315_tons

Total, Tons......1,747,919

Analysis: See analyses of Groups 2, 3 and 7.

ONONDAGA MINE.

Location: St. Louis County, Minnesota, Section 4, Township 58,

Range 17.

Description: First opened up in 1907. The ore is a soft, gray, Bessemer Hematite, and is not crushed. The mine is worked by the slicing system, the greatest vertical depth being 237 feet. The ore is shipped via the Great Northern Railway to Allouez Bay, and thence by boat to lower lake ports.

Operating Company: Republic Iron & Steel Co., Youngstown, Ohio.

Manager: F. J. Webb.

Superintendent: Wm. White.

Sales Agents: Republic Iron & Steel Co., Youngstown, Ohio.

Yearly Shipments:

1907— **521 tons** 1911— 63,798 tons 1908--- 30,887 tons 1912-1909— 59,389 tons 1913— 6,847 tons 1910- 61,935 tons

Total, Tons......223,377

The average of all cargo analyses for 1913 is as fol-Analysis:

Dried at 212° F. lows:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. 55.00 .023 18.50 .08 1.30 .60 .75 .05 .007

The ore in its natural state is as follows:

Moist Iron Phos. Silica 6.80 51.26 .021

PEARCE MINE.

Location: St. Louis County, Minnesota, N. E. 1/4 of N. W. 1/4, Section 28, Township 58, Range 20.

Description: First opened up in 1902. The ore is soft, darkbrown, Bessemer Hematite. Slicing system of mining is used. The greatest vertical depth is 110 feet.

The ore is shipped via the Great Northern Railway to Allouez Bay and from there by boat to the lower lake ports.

Operating Company: Meriden Iron Co., Hibbing, Minn.

Manager: O. B. Warren.

Superintendent: J. A. MacKillican.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

Analysis: The average of all cargo analyses for 1913 is as fol-

lows: Dried at 212° F.

 Iron
 Phos. Silica
 Mang. Alum.
 Linre Magnes.
 Sulph. Loss

 59.26
 .046
 7.54
 .68
 1.71
 .31
 .38
 .008
 4.30

The ore in its natural state is as follows:

Moist Iron Phos. Silica 9.00 53.93 .042 6.86

PEARSON MINE.

Location: Itasca County, Minnesota, Section 29, Township 57, Range 22.

Description: First opened up in 1909. The ore is a soft, brown, Bessemer Hematite, and is not crushed. The mine is worked by the caving and slicing systems, the greatest vertical depth being 165 feet. The ore is shipped via the Great Northern Railway to Allouez Bay, and thence by boat to lower lake ports.

Operated by: R. M. Sellwood, Duluth, Minn.

Manager: R. M. Sellwood.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

Analysis: The average of all cargo analyses for 1913 is as fol-

lows: Dried at 212° F.

 Iron
 Phos. Silica
 Mang. Alum. Lime
 Magnes. Sulph. Loss

 53.00
 .038
 18.44
 .94
 1.37
 .25
 .19
 .007
 2.60

The ore in its natural state is as follows:

Moist Iron Phos. Silica 9.00 48.23 .034 16.78

PENOBSCOT MINE.

Location: St. Louis County, Minnesota, Section 1, Township 57, Range 21.

Description: First opened up in 1897. The ore was a Bessemer and Non-Bessemer Hematite.

The mine was operated by The Oliver Iron Mining Company.

Yearly Shipments:

1897— 11,933 tons	1902—209.531	tons
1898— 29,652 tons	1903— 1,615	tons
1899— 85,619 tons	1911— 189	tons
1900—146,641 tons	1912—	
1901—221,080 tons	1913—	
Total,	Tons706,260	

PERKINS MINE.

Location: St. Louis County, Minnesota, Section 26, Township 59, Range 15.

Description: First opened up in 1909. The ore is a soft, brown, Non-Bessemer Hematite, and is not crushed. The mine is worked by the open-pit system, the greatest vertical depth being 135 feet. The ore is shipped via the D. & I. R. Railroad to Two Harbors, and thence by boat to lower lake ports.

Operating Company: Perkins Mining Co., Duluth, Minn.

Manager: R. M. Sellwood.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

1909— 59,029 tons 1910— 80,622 tons 1912— 60,523 tons 1913-120,012 tons 1911— 44,933 tons

Total, Tons..........365,119

Analysis: The average of all cargo analyses for 1913 is as fol-

Dried at 212° F. lows:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss .081 5.92 59.00 .64 1.86 .24 .19 .009 6.72

The ore in its natural state is as follows:

Moist Iron Phos. Silica 14.50 50.45 .069

PETTIT MINE.

Location: St. Louis County, Minnesota, Section 25, Township 58, Range 17.

Description: First opened up in 1902. The ore is a soft, red, Non-Bessemer Hematite, and is not crushed. The mine is worked by the slicing system, the greatest vertical depth being 250 feet. The ore is shipped via the D. & I. R. Railroad to Two Harbors, and thence by boat to lower lake ports.

Operating Company: Republic Iron & Steel Co., Youngstown, Ohio.

Manager: F. J. Webb.

Superintendent: D. T. Caine.

Sales Agents: M. A. Hanna & Co., Cleveland, Ohio.

Yearly Shipments:

1902— 17,278 tons	1908— 57,140 tons
1903— 52,706 tons	1909— 83,548 tons
1904— 27,088 tons	1910— 62,456 tons
1905—140,239 tons	1911—129,776 tons
1906— 82,757 tons	1912—157,208 tons
1907— 36,074 tons	1913—131,864 tons
Total Tons	978 13 <i>4</i>

Analysis: The average of all cargo analyses for 1913 is as fol-

lows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 57.00 .058 10.00 .45 2.20 .17 .06 .011 5.26

The ore in its natural state is as follows:

Moist Iron Phos. Silica 13.00 49.59 .050 8.70

PILLSBURY MINE.

Location: St. Louis County, Minnesota, Section 29, Township 58, Range 20.

Description: First opened up in 1898. The ore was a Bessemer and Non-Bessemer Hematite. The open-pit system of mining was used.

The mine was operated by The Oliver Iron Mining Company.

Yearly Shipments:

1898— 99,691 tons	1904—	
1899—106,487 tons	1905—161,924	tons
1900—101,032 tons	1906— 33,546	tons
1901—120,723 tons	1907—489,718	tons
1902—238,122 tons		
1903—229,133 tons	•	
	Tons1,640,265	

ROBERTS MINE.

Location: St. Louis County, Minnesota, S. W. ¼ of N. W. ¼, Section 8, Township 58, Range 16.

Description: First opened up in 1897. The ore is soft, brown, Bessemer Hematite. The caving system of mining is used. The greatest vertical depth is 65 feet.

The ore is shipped via the Duluth & Iron Range Railroad to Two Harbors, and from there by boat to the lower lake ports.

Yearly Shipments:

1897— 18,614 tons	1906
1898—	1907—
1899— 57,847 tons	1908—
1900 41,965 tons	1909
1901— 42,756 tons	1910— 26,915 tons
1902— 28,972 tons	1911—
1903—	1912— 12,384 tons
1904—	1913— 13,387 tons
1905—	

Total, Tons......242,840

SAUNTRY-ALPENA MINE.

Location: St. Louis County, Minnesota, Sections 5 and 6, Township 58, Range 17.

Description: First opened up in 1898. This mine ships five grades of ore: GROUP 2, a soft, reddish-brown, Bessemer Hematite; GROUP 3, a soft, reddish-yellow, Non-Bessemer Hematite; GROUP 5, a soft, grayish-black, Bessemer Hematite; and GROUPS 7 and 9, both soft, reddish-yellow, Non-Bessemer Hematites. The ore is not creshed. The mine is worked by underground methods, the greatest vertical depth being 286 feet. The ore is shipped via the D. M. & N. Railway to Duluth, and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Virginia, Minn. General Manager: J. H. McLean.

General Superintendent: M. H. Godfrey.

Yearly Shipments:

1898— 53,004 tons	1910— 242.373 tons
1899— 68,560 tons	1911—1,057,819 tons
1900— 328,739 tons	1912—1,025,301 tons
1901— 249,837 tons	1913—1,705,131 tons
Total, Tons	4,730,764

Analysis: See analyses of Groups 2, 3, 5, 7 and 9.

SCHLEY MINE.

Location: St. Louis County, Minnesota, Section 25, Township 58, Range 17.

Description: First opened up in 1910. The mine ships two grades of ore: SCHLEY, a soft, red, Bessemer and Non-Bessemer Hematite; and SCHLEY NO. 2, a soft, red, Non-Bessemer Hematite. The ore is not crushed. The mine is worked by the slicing system, the greatest vertical depth being 244 feet. The ore is shipped via the D. & I. R. Railroad to Two Harbors, and thence by boat to lower lake ports.

Operating Company: Republic Iron & Steel Co., Youngstown, Ohio.

Manager: F. J. Webb.

Superintendent: D. T. Caine.

Sales Agents: M. A. Hanna & Co., Cleveland, Ohio.

Yearly Shipments:

1912—159,126 tons 1913—202,477 tons 1910— 13,369 tons 1911—120,365 tons 1913— Total, Tons...........495,337

Analysis: The average of all cargo analyses for 1913 is as fol-

Dried at 212° F. lows:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 55.00 .058 11.50 .80 2.30 .23 .19

The ore in its natural state is as follows:

Moist Iron Phos. Silica 12.50 48.13 .051 10.60

SCRANTON MINE (Formerly Elizabeth Mine).

Location: St. Louis County, Minnesota, Section 12, Township 57, Range 21.

Description: First opened up in 1904. The ore is a soft, red, Non-Bessemer Hematite, and is not crushed. The mine is worked by the slicing system, the greatest vertical depth being 240 feet. The ore is shipped via the Great Northern and the D. M. & N. Railways to Superior and Duluth, and thence by boat to lower lake ports.

Operating Company: Scranton Mining Co., Cleveland, Ohio.

Manager: C. H. Munger.

Superintendent: Robt. Murray.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

1904— 1,168 tons 1909— 1910— 7,214 tons 1905-1911-1906-1912—245,500 tons 1913—227,270 tons 1907-1908-

Total, Tons...........490,152

Analysis: The average of all cargo analyses for 1913 is as fol-

Dried at 212° F. lows:

Mang. Lime Magnes. Sulph. Iron Phos. Silica Alum. Loss 7.68 53.30 .082 9.23 .56 .32 .26 .010 5.60

The ore in its natural state is as follows:

Moist Iron Phos. Silica 15.00 45.31 .069 7.84

SECTION 17 MINE.

Location: St. Louis County, Minnesota, Section 17, Township 58, Range 19.

Description: First opened up in 1912. The ore, EUCLID, is a soft, red, Non-Bessemer Hematite, and is not crushed. The mine is worked by underground methods, the greatest vertical depth being 120 feet. The ore is shipped via the Great Northern Railway to Allouez Bay and thence by boat to lower lake ports.

Operated by: A. B. Coates, Virginia, Minn.

Manager: A. B. Coates.

Superintendent: C. F. Bellamy. Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

1912— 4,203 tons 1913— Total, Tons......20,849 1913— 16,646 tons

Analysis: See analysis of EUCLID ore.

SELLERS MINE.

Location: St. Louis County, Minnesota, Section 6, Township 57, Range 20.

Description: First opened up in 1895. This mine ships five grades of ore: GROUP 2, a soft, brownish-black, Bessemer Hematite; GROUPS 3, 7 and 9, all soft, reddish-yellow, Non-Bessemer Hematites; and GROUP 5, a soft, grayish-black, Bessemer Hematite. The ore is not crushed. The mine is worked by the open-pit system. The ore is shipped via the D. M. & N. Railway to Duluth, and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Hibbing, Minn. General Manager: J. H. McLean.

General Superintendent: W. J. West.

Yearly Shipments:

Snipments:	
1895— 47,433 tons	1905—261,501 tons
1896—153,037 tons	1906—241,031 tons
1897—	1907—155,060 tons
1898—112,765 tons	1908—354,780 tons
1899—174,867 tons	1909—626,169 tons
1900 56,280 tons	1910—954,042 tons
1901— 34,918 tons	1911— 87,275 tons
1902—193,428 tons	1912—
1903—251,631 tons	1913—268,070 tons
1904207.990 tons	

Total, Tons.....4,180,277

Analysis: See analyses of Groups 2, 3, 5, 7 and 9.

SHARON MINE.

Location: St. Louis County, Minnesota, Section 20, Township 58, Range 19.

Description: First opened up in 1901. The ore was a Non-Bessemer Hematite.

The mine was operated by the Oliver Iron Mining Company.

Yearly Shipments:

1901— 56,810 tons 1903— 48,199 tons 1902—224,526 tons Total, Tons......329,535

SHENANGO MINE.

Location: St. Louis County, Minnesota, Sections 22, 23 and 27, Township 58, Range 20.

Description: First opened up in 1901. The ore is of two grades: SHENANGO, a soft, brown, Bessemer Hematite; and WIL-PEN, a soft, brown, Non-Bessemer Hematite; and is not crushed. The mine is worked by open-pit and underground methods, the greatest vertical depth being 295 feet. The ore is shipped via the D. M. & N. Railway to Duluth, and thence by boat to lower lake ports.

Operating Company: Shenango Furnace Co., Chisholm, Minn. Manager: E. J. Maney.

Superintendent: Richard Hodge.

Yearly Shipments:

 1904—51,712 tons
 1909—831,099 tons

 1905—213,097 tons
 1910—965,148 tons

 1906—383,717 tons
 1911—732,978 tons

 1907—387,093 tons
 1912—805,413 tons

 1908—461,887 tons
 1913—794,911 tons

 Total, Tons
 5,637,055

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Shenango:

 Iron
 Phos.
 Silica
 Mang.
 Alum.
 Lime Magnes.
 Sulph.
 Loss 59.79

 59.79
 .048
 5.32
 1.07
 1.76
 .20
 .17
 .004
 5.40

 Wilpen:

Phos. Silica Mang. Iron Alum. Lime Magnes. Sulph. Loss 57.48 .069 6.53 1.15 2.46 .28 .18 .004 5.80 The ore in its natural state is as follows:

Shenango:

Moist Iron Phos. Silica 11.60 52.85 .042 4.70 Wilpen:

Moist Iron Phos. Silica 13.20 49.89 .060 5.67

SOUTH UNO MINE.

Location: St. Louis County, Minnesota, Section 2, Township 57, Range 21.

Description: First opened up in 1910. This mine ships four grades of ore: GROUPS 2 and 8, soft, brownish-yellow, Bessemer Hematites; and GROUPS 3 and 7, soft, brownishyellow, Non-Bessemer Hematites. The ore is not crushed. The mine is worked by the open-pit method. The ore is shipped via the Great Northern Railway to Superior, and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Hibbing, Minn.

General Manager: J. H. McLean. General Superintendent: W. J. West.

Yearly Shipments:

1912—1,305,216 tons 1913—1,202,341 tons 1910---1911- 266,390 tons Total, Tons......2,773,947

Analysis: See analyses of Groups 2, 3, 7 and 8.

SPRING MINE.

Location: St. Louis County, Minnesota, Section 11, Township 59, Range 14.

Description: First opened up in 1906. The ore is a soft, gray, Bessemer Hematite, and is not crushed. The mine is worked by open-pit and underground methods, the greatest vertical depth being 150 feet. The ore is shipped via the D. & I. R. Railroad to Two Harbors, and thence by boat to lower lake ports.

Operating Company: Spring Mining Co., Mesaba, Minn.

Superintendent: Andrew Holler.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

1907— 15,257 tons 1908— 20,516 tons 1911-1912-1909-1913-

Analysis: The expected analysis for 1914 is as follows: at 212° F.

Silica Iron Phos. Mang. Alum. Lime Magnes. Sulph. Loss 52.22 22.00 .033 .32 .88 .16 .18 .011 2.21 The ore in its natural state is as follows:

Moist Iron Phos. Silica 9.20 47.42 .030 19.97

SPRUCE MINE.

Location: St. Louis County, Minnesota, Section 31, Township

58, Range 17.

Description: First opened up in 1894. This mine ships two grades of ore: GROUP 1, a soft, dark-brown, Bessemer Hematite; and GROUP 4, a soft, yellowish-brown, Non-Bessemer Hematite. The ore is not crushed. The mine is worked by underground methods, the greatest vertical depth being 281 feet. The ore is shipped via the D. & I. R. Railroad to Two Harbors, and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Eveleth, Minn. General Manager: J. H. McLean.

General Superintendent: R. J. Mitchell.

Yearly Shipments:

```
1894— 5,628 tons
1895— 47,700 tons
1896— 96,280 tons
1897— 12,215 tons
                                                                   1904—589,319 tons
1905—606,295 tons
1906—674,602 tons
                                                                   1907-610,457 tons
                                                                   1908-430,633 tons
1898
1899— 1,621 tons
1900—
                                                                   1909—579,903 tons
1910—613,947 tons
1901—279,515 tons
1902—543,203 tons
1903—587,153 tons
                                                                   1911-638,180 tons
                                                                   1912—740,801 tons
1913—544,876 tons
                      Total, Tons...........7,602,328
```

Analysis: See analyses of Groups 1 and 4.

ST. CLAIR MINE.

Location: St. Louis County, Minnesota, Section 23, Township

58, Range 20.

Description: First opened up in 1900. The ore was a Non-Bessemer Hematite.

The mine was operated by the Oliver Iron Mining Company.

Yearly Shipments:

1900—101,675 tons	1903— 6,148 tons
1901—	1904— 26,748 tons
1902—	1905— 61,792 tons
Total Tons	196.363

ST. JAMES MINE.

Location: St. Louis County, Minnesota, Section 3, Township 58, Range 15.

Description: First opened up in 1906. The ore is soft, blue, Non-Bessemer Hematite. The underground system of mining is used.

The ore is shipped via the Duluth & Iron Range Railroad to Two Harbors, Minn.

Sales Agents: Corrigan, McKinney & Co., Cleveland, Ohio.

Analysis: The expected analysis for 1914 is as follows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 57.65 .077 8.95 .63 2.95 .28 .15 .008 4.45

The ore in its natural state is as follows:

Moist Iron Phos. Silica 11.75 50.87 .068 7.89

ST. PAUL MINE.

Location: Itasca County, Minnesota, Section 24, Township 57, Range 22.

Description: First opened up in 1905. The ore is soft, blue, Non-Bessemer Hematite. Open-pit system of mining is used. The ore is shipped via the Great Northern Railway to Allouez Bay, and from there by boat to the lower lake ports.

Sales Agents: Corrigan, McKinney & Co., Cleveland, Ohio.

Yearly Shipments:

Analysis: The average of all cargo analyses for 1913 is as fol-

lows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 57.75 .065 8.60 .15 3.61 .35 .40 .007 4.55

The ore in its natural state is as follows:

Moist Iron Phos. Silica 11.80 50.93 .057 7.58

STEPHENS MINE.

Location: St. Louis County, Minnesota, Sections 23, 25 and 26, Township 59, Range 15.

Description: First opened up in 1903. The ore was Non-Bessemer Hematite.

The mine was operated by the Oliver Iron Mining Company.

Yearly Shipments:

1903— 87,055 tons 1905—367,764 tons

Total, Tons......454,819

STEVENSON MINE.

Location: St. Louis County, Minnesota, Sections 7 and 8, Township 57, Range 21.

Description: First opened up in 1900. This mine ships two ores: STEVENSON, a soft, blue, Bessemer Hematite, and WALLACE, a soft, blue, Non-Bessemer Hematite. Open-pit system of mining is used.

The ore is shipped via the Great Northern Railway to Allouez Bay, and from there by boat to the lower lake ports.

Sales Agents: Corrigan, McKinney & Co., Cleveland, Ohio.

Yearly Shipments:

marshauren .				
1900— 56,031 t	ons	1907-1	,142,977	tons
1901— 666,273 t			516,770	
1902—1,434,681 t			,030,742	
1903—1,014,582 t			953,079	
1904—1,652,021 t			500,323	
1905—1,428,614 t			682,514	
1906—1,041,500 t			634,656	tons
Tot	tal Tons 12	754 763		

The average of all cargo analyses for 1913 is as fol-Dried at 212° F. Analysis:

lows:

Phos. Silica Mang. Alum. Lime Magnes. Sulph. Iron Loss 60.25 .95 .042 6.50 .75 .80 .50 .008 The ore in its natural state is as follows:

Moist Iron Phos. Silica 9.15 54.74 .038

SUSQUEHANNA MINE.

Location: St. Louis County, Minnesota, Section 6, Township 57, Range 20.

Description: First opened up in 1906. This mine ships four grades of ore: SUSQUEHANNA, BUFFALO and SEN-ECA, all soft, red, Non-Bessemer Hematites; and CARSON, a soft, red, Bessemer Hematite. The ore is not crushed. The mine is worked by the steam-shovel method, the greatest vertical depth being 190 feet. The ore is shipped via the D. M. & N. Railway to Duluth, and thence by boat to lower lake ports.

Operating Company: Rogers-Brown Iron Co., Buffalo, N. Y.

Manager: W. C. Agnew.

Superintendent: A. O. Wilson.

Sales Agents: Rogers-Brown Iron Co.

Yearly Shipments:

1906— 20,984 tons	1910—176,869	tons
1907—137,207 tons	1911—147,741	tons
1908—182,352 tons		
1909-243,049 tons	1913—904,019	tons
. Total,	Tons2,396,131	

Loss

5.56

Loss

5.82

Loss

5.27

Analysis: The average of all cargo analyses for 1913 is as fol-Dried at 212° F. lows:

Alum.

Alum.

Alum.

2.64

3.05

.13

.11

.10

3.91

Lime Magnes. Sulph.

Lime Magnes. Sulph.

.10

Lime Magnes. Sulph.

.12

.019

.017

Susquehanna: Silica Iron Phos. Mang. 58.95 .078 6.48 .65 Seneca: Mang. Iron Phos. Silica 57.81 .075 6.77 1.59 Carson: Phos. Silica Iron Mang. 59.83 .044 6.36 .61 The ore in its natural state is as follows: Susquehanna: Moist Iron Phos. Silica 14.87 50.18 .066 Seneca: Moist Iron Phos. Silica 16.04 48.54 .063 5.68 Carson: Moist Phos. Iron Silica

SWEENY MINE.

Location: St. Louis County, Minnesota, Sections 3 and 4, Township 57, Range 21.

Description: First opened up in 1908.

49.74

.036

5.29

The mine was operated by the Oliver Iron Mining Company.

Yearly Shipments:

16.86

1908— 7,579 tons 1910-769 tons Total, Tons8,348

TROY MINE.

Location: St. Louis County, Minnesota, Section 7, Township 57, Range 17.

Description: First opened up in 1903. The ore is a soft, red, Bessemer Hematite, and is not crushed. The mine is worked by the slicing system, the greatest vertical depth being 189 The ore is shipped via the D. M. & N. Railway to Duluth, and thence by boat to lower lake ports.

Operating Company: Crete Mining Co., Cleveland, Ohio.

Manager: C. H. Munger. Superintendent: W. P. Chinn.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

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Yearly Shipments:
           1903— 15,099 tons
1904— 12,759 tons
1905— 87,584 tons
                                                        1909— 86,520 tons
1910—104,057 tons
                                                        1911-
           1906—146,849 tons
1907—100,730 tons
1908— 40,283 tons
                                                        1912-
                                                        1913— 70,748 tons
                           Total, Tons............664,629
Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.
     Iron
               Phos. Silica
                                  Mang. Alum. Lime Magnes. Sulph.
                                                      .47
                                                                  .80
                                                                                    5.52
     51.50
                .039
                        16.27
                                    .90
                                            1.87
                                                                           .238
     The ore in its natural state is as follows:
     Moist Iron Phos. Silica
    13.75
             44.42
                      .033
                              14.03
```

UNION MINE.

Location: St. Louis County, Minnesota, Section 9, Township 58, Range 17.

Description: First opened up in 1900. This mine ships three ores: UNION, OXFORD and OXFORD NO. 2, all soft, red and blue, Non-Bessemer Hematites, which are not crushed. The mine is worked by steam-shovel, the greatest vertical depth being 204 feet. The ore is shipped via the D. & I. R. Railroad to Two Harbors, and thence by boat to lower lake ports.

Operating Company: Union Ore Co., Youngstown, Ohio.

Manager: F. J. Webb.

Superintendent: Wm. White.

Sales Agents: Oglebay, Norton & Co., Cleveland, Ohio.

Yearly Shipments:

1900— 8.297 tons	1906— 20,691 ton	s
1901— 93,109 tons	1907— 61,825 ton	S
1902—103,522 tons	1908— 20,937 ton	s
1903— 91,496 tons	1911—	
1904	1912—213,829 ton	
1905—	1913—286,934 ton	5
Total,	Tons900,640	

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F

lows:	Dried	at 212°	r.					
Union:								
Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sulph.	Loss
60.00	.045	7.70	.70	1.90	.21	.14	.010	3.30
Oxford:								
Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sulph.	Loss
55.50	.080	7.60	1.25	3.10	.27	.23	.012	7.70
Oxford N	lo. 2:							
Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sulph.	Loss
50.50	.085	12.60	1.60	3.90	.27	.25	.014	8.55

The ore in its natural state is as follows: Union: Phos. Silica Moist Iron 55.50 7.50 .042 Oxford: Iron Phos. Silica Moist 6.57 13.50 48.00 .069 Oxford No. 2: Moist Iron Phos. Silica 14.50 43.18 .073 10.77

UTICA MINE.

Location: St. Louis County, Minnesota, Sections 2 and 11, Township 57, Range 21.

Description: First opened up in 1902. This mine ships three grades of ore: ALBANY, a soft, yellow, Non-Bessemer Hematite; ALBANY-REX, a soft, blue, Non-Bessemer Hematite; and CRETE, a soft, red, Bessemer Hematite. The ore is not crushed. The mine is worked by open-pit and underground slicing methods, the greatest vertical depth being 240 feet. The ore is shipped via the Great Northern Railway to Superior, and thence by boat to lower lake ports.

Operating Company: Crete Mining Co., Cleveland, Ohio.

Manager: C. H. Munger.

Superintendent: Robt. Murray.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

1902— 9,009 tons 1908— 57,194 tons 1903—156,180 tons 1909—201,480 tons 1904—120,697 tons 1910—232,582 tons 1905—185,944 tons 1911—100,123 tons 1906—268,281 tons 1912—223,006 tons 1907—304,864 tons 1913—352,932 tons Total, Tons ... 2,212,292

Analysis: See analyses of Albany, Albany-Rex and Crete ores.

VICTORIA MINE.

Location: St. Louis County, Minnesota, Section 9, Township 58, Range 17.

Description: First opened up in 1906. The ore is soft, red, Non-Bessemer Hematite. The slicing system of mining is used. The greatest vertical depth is 167 feet.

The ore is shipped via the Duluth & Iron Range Railroad to Two Harbors, and from there by boat to the lower lake ports.

Operating Company: Republic Iron & Steel Co., Youngstown, Ohio.

Manager: F. J. Webb.

Superintendent: Wm. White.

Sales Agents: Republic Iron & Steel Co., Youngstown, Ohio.

Yearly Shipments:

Analysis: The expected analysis for 1914 is as follows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 58.00 .056 8.36 1.50 1.75 .23 .15 .015 4.10 The ore in its natural state is as follows:

Moist Iron Phos. Silica 9.29 52.61 .051 7.58

VIRGINIA MINE.

Location: St. Louis County, Minnesota, Section 30, Township 58, Range 17.

Description: First opened up in 1893. This mine ships two ores: VIRGINIA BESSEMER, a hard, mixed, Bessemer Hematite, and VIRGINIA NON-BESSEMER, a hard, mixed, Non-Bessemer Hematite. The ore is crushed. The mine is worked by the open-pit method. The ore is shipped via the D. & I. R. Railroad to Two Harbors, and thence by boat to lower lake ports. Mine is now idle.

Yearly Shipments:

1910—299,046 tons 1912—200,182 tons 1911— 97,667 tons 1913—391,109 tons Total, Tons......988,004

Analysis: 'The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Virginia Bessemer:

Mang. Phos. Silica Alum. Lime Magnes. Sulph. Iron Loss 56.30 .039 11.18 .98 1.64 .48 .65 .072 4.14 Virginia Non-Bessemer:

 Iron
 Phos. Silica
 Mang. Alum
 Lime Magnes. Sulph.
 Loss 55.10

 55.10
 .064
 9.26
 1.39
 2.73
 .47
 .97
 .228
 5.73

The ore in its natural state is as follows:

Virginia Bessemer:

Moist Iron Phos. Silica 12.00 49.54 .034 9.83

 Virginia
 Non-Bessemer:

 Moist
 Iron
 Phos.
 Silica

 13.00
 47.94
 .055
 8.05

VIRGINIA SLIVER MINE.

Location: St. Louis County, Minnesota, Sections 5 and 6, Township 58½, Range 17.

Description: First opened up in 1908. The mine ships three ores: DOVER, a soft, red, Non-Bessemer Hematite; WEL-LINGTON, a soft, red, Non-Bessemer Hematite; and SLIV-ER MANGANESE, a soft, red, Non-Bessemer, Manganiferous Hematite. The ore is not crushed. The mine is worked by the steam-shovel method. The ore is shipped via the D. M. & N. Railway to Duluth, and thence by boat to lower lake ports.

Operating Company: Virginia Ore Mining Co., Virginia, Minn.

Manager: James D. Ireland. Superintendent: C. E. Hendrick.

Sales Agents: M. A. Hanna & Co., Cleveland, Ohio.

Yearly Shipments:

1908— 49,291 tons 1911—167,225 tons 1909—256,073 tons 1912—378,541 tons 1910—358,432 tons 1913—298,006 tons

Total, Tons......1,507,568

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Dover:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 58.10 .065 7.40 .53 2.90 .23 .17 .014 5.32

The ore in its natural state is as follows:

Dover:

Moist Iron Phos. Silica 14.07 49.93 .056 6.36

VIVIAN MINE.

Location: St. Louis County, Minnesota, Section 20, Township 59, Range 14.

Description: First opened up in 1912. The ore, which goes into GROUP 4, is a soft, yellowish-brown, Non-Bessemer Hematite, and is not crushed. The mine is worked by underground methods, the greatest vertical depth being 150 feet. The ore is shipped via the D. & I. R. Railroad to Two Harbors, and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Mesaba, Minn.

General Manager: J. H. McLean. General Superintendent: C. Trezona.

Yearly Shipments:

1913— 9,093 tons

Analysis: See analysis of Group 4.

WACOOTAH MINE.

Location: St. Louis County, Minnesota, Sections 3 and 11, Township 58, Range 18 West.

Description: First opened up in 1906. The ore is a soft, brown, Non-Bessemer Hematite. Stripping method of mining is used. The ore is shipped via the Duluth, Missabe & Northern Railway to Allouez Bay, and from there by boat to the lower lake

Operating Company: Pitt Iron Mining Company, Steubenville, Ohio.

Superintendent: C. E. Moore.

Sales Agents: La Belle Iron Works, Steubenville, Ohio.

Yearly Shipments:

1910— 35,498 tons 1911— 7,805 tons 1906- 6,766 tons 1907—158,692 tons 1912—129,073 tons 1913— 43,549 tons 1908-1909— 60,966 tons 1913-Total, Tons......442,349

Analysis: The average of all cargo analyses for 1913 is as fol-

Dried at 212° F. lows:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 57.67 .095 5.67 .89 5.81

The ore in its natural state is as follows:

Moist Iron Phos. Silica 13.15 50.09 .082

WEBB MINE.

Location: St. Louis County, Minnesota, Section 6, Township 57, Range 20.

Description: First opened up in 1905. The ore is a soft, brown, Bessemer Hematite, and is not crushed. The mine is worked by underground methods, the greatest vertical depth being 236 feet. The ore is shipped via the D. M. & N. Railway to Duluth, and thence by boat to lower lake ports.

Operating Company: Shenango Furnace Co., Hibbing, Minn. Manager: E. J. Maney.

Superintendent: Thos. Turnbull.

Yearly Shipments:

1905— 71,235 tons 1906—165,604 tons 1910— 46,384 tons 1911— 20,237 tons 1907—113,334 tons 1912—166,636 tons 1908— 19,610 tons 1913—236,579 tons 1909—

Total, Tons......839,619

The average of all cargo analyses for 1913 is as fol-Analysis:

Dried at 212° F. lows:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 53.58 .91 1.67 .14 Trace .054 14.27

The ore in its natural state is as follows:

Moist Iron Phos. Silica 47.42 .048 12.63 11.50

WHITESIDE MINE.

Location: St. Louis County, Minnesota, Section 15, Township 58, Range 19.

Description: First opened up in 1909. The ore is a soft, brown, Non-Bessemer Hematite, and is not crushed. The mine is worked by underground methods, the greatest vertical depth being 216 feet. The ore is shipped via the D. M. & N. Railway to Duluth, and thence by boat to lower lake ports.

Operating Company: Shenango Furnace Co., Buhl, Minn.

Manager: E. J. Maney.

Superintendent: A. J. Loomis.

Yearly Shipments:

1913— 76,897 tons

1911—130,198 tons 1912—275,915 tons Total, Tons.......483,010

The average of all cargo analyses for 1913 is as fol-

Dried at 212° F. lows:

Phos. Silica Mang. Alum. Iron Lime Magnes. Sulph. Loss 8.75 1.32 .34 55.42 .092 4.00 6.75

The ore in its natural state is as follows:

Moist Iron Phos. Silica 9.20 50.32 .083

WILLIAMS MINE.

Location: St. Louis County, Minnesota, Section 2, Township 58,

Range 16.

First opened up in 1895. Two ores are shipped Description: from this mine: WILLIAMS, a dark-brown, Bessemer Hematite; and MILWAUKEE, dark-brown, Non-Bessemer Hema-

Underground method of mining is now used.

The greatest vertical depth is 110 feet. The ore is shipped via the Duluth & Iron Range Railroad to Two Harbors, and from there by boat to the lower lake ports.

Operated by: John M. Thomas, 740 Kinnickinnic Ave., Milwaukee, Wisconsin.

Superintendent: Guy A. Richards.

```
Yearly Shipments:
             1895— 3,046 tons
                                                                  1905-
             1896-
                    - 11,249 tons
                                                                 1906— 17,685 tons
1907— 35,267 tons
             1897-
             1898-
                                                                 1908-
             1899— 12,357 tons
1900— 18,238 tons
                                                                 1909-
                                                                  1910-
                                                                 1911— 11,250 tons
1912— 39,274 tons
1913— 76,703 tons
             1901-
             1902-
             1903-
             1904-
                               Total, Tons......225,069
```

WILLS MINE.

Location: St. Louis County, Minnesota, Sections 17 and 18, Township 56, Range 16.

Description: First opened up in 1902. The ore is a soft, red, Non-Bessemer Hematite, and is not crushed. The mine is worked by the slicing system, the greatest vertical depth being 86 feet. The ore is shipped via the D. & I. R. Railroad to Two Harbors and thence by boat to lower lake ports.

Operating Company: Republic Iron & Steel Co., Youngstown, Ohio.

Manager: F. J. Webb.

Superintendent: P. S. Kurtzman.

Sales Agents: M. A. Hanna & Co., Cleveland, Ohio.

Yearly Shipments:

Dispersion .	
1902— 12,158 tons	1908—
1903—	1909— 3,440 tons
1904	1910— 26,712 tons
1905— 4,550 tons	1911—
1906—	1912—
1907—	1913—

Total, Tons...........46,860

Analysis: The expected analysis for 1914 is as follows: Dried

at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 52.80 .080 13.30 2.00 1.70 .10 .35 .012 5.70

The ore in its natural state is as follows:

Moist Iron Phos. Silica 11.00 47.00 .071 11.48

WINIFRED MINE.

Location: St. Louis County, Minnesota, Section 31, Township 58, Range 20.

Description: First opened up in 1903. This mine ships four grades of ore: GROUPS 2 and 5, soft, reddish-brown, Bessemer Hematites; and GROUPS 3 and 7, soft, reddish-brown,

Non-Bessemer Hematites. The ore is not crushed. The mine is worked by underground methods, the greatest vertical depth being 165 feet. The ore is shipped via the D. M. & N. Railway to Duluth, and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Hibbing, Minn. General Manager: J. H. McLean.

General Superintendent: W. J. West.

Yearly Shipments:

1909— 84,614 tons
1910— 67,686 tons
1911— 52,385 tons
1912— 91,806 tons
1913— 43,109 tons
·

Total, Tons.......620,088

Analysis: See analyses of Groups 2, 3, 5 and 7.

WOODBRIDGE MINE.

Location: St. Louis County, Minnesota, Section 16, Township 58,

Range 19.

Description: First opened up in 1912. The ore is a soft, lightbrown, Non-Bessemer Hematite. Slicing system of mining is used. Greatest vertical depth is 200 feet. The ore is shipped via the Duluth, Missabe & Northern Railway to Duluth, and from there to the lower lake ports by boat.

Operating Company: The Fort Henry Mining Company, Wade Bldg., Cleveland, Ohio.

Superintendent: R. A. Angst.

Sales Agents: Oglebay, Norton & Company, Cleveland, Ohio.

Yearly Shipments:

```
1912— 68,098 tons
Total, Tons........231,855
                                      1913—163,757 tons
```

alysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Mang. Alum. Lime Magnes. Sulph. 1.15 3.41 .54 .35 .013 Phos. Silica Iron 57.50 7.01 .076 5.36

The ore in its natural state is as follows:

Moist Iron Phos. Silica 13.00 50.03 .066

YATES MINE.

Location: St. Louis County, Minnesota, Section 11, Township 58, Range 19.

Description: First opened up in 1904. The ore was a soft, red, Non-Bessemer Hematite. Underground system of mining was used. The mine is idle.

The ore was shipped via the Great Northern Railway to Superior, and from there by boat to the lower lake ports.

Sales Agents: M. A. Hanna & Company, Cleveland, Ohio.

Yearly Shipments:

1904— 53,179 tons 1905— 58,174 tons 1907—210,289 tons 1908— 86,308 tons 1906-265,289 tons 1909-5,362 tons Total, Tons.........679,038

YAWKEY MINE

Location: St. Louis County, Minnesota, Section 9, Township 58, Range 17.

Description: First opened up in 1907. The ore is a soft, red, Non-Bessemer Hematite, and is not crushed. The mine is worked by the slicing system, the greatest vertical depth being 128 feet. The ore is shipped via the D. & I. R. Railroad to Two Harbors, and thence by boat to lower lake ports.

Operating Company: Hobart Iron Co., Cleveland, Ohio.

Manager: C. H. Munger.

Superintendent: W. P. Chinn.
Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

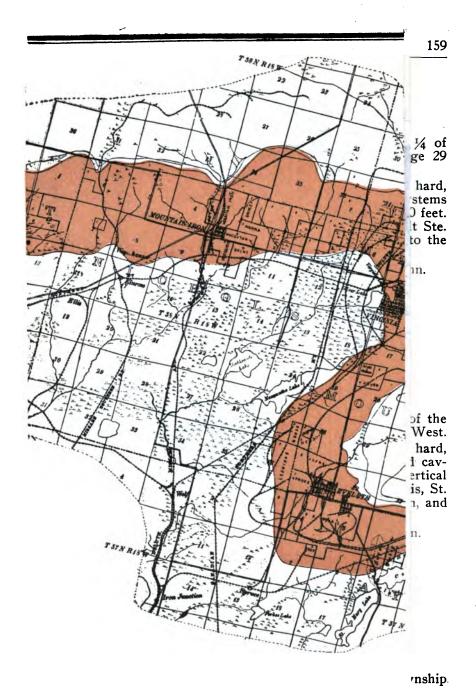
1907— 15,453 tons 1908— 84,446 tons 1909— 45,790 tons 1910— 30,439 tons 1911-1912— 1913— 40,878 tons Total, Tons......217,006

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Mang. Alum. 2.23 Phos. Silica Lime Magnes. Sulph. Iron 54.36 .083 11.00 .19 .31 .012

The ore in its natural state is as follows:

Moist Iron Phos. Silica 9.48 13.80 46.86 .071



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Analysis lows:
Iron
54.36
The (
Moist
13.80

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CUYUNA RANGE.

ARMOUR NO. 1 MINE.

Location: Crow Wing County, Ironton, Minnesota, S. E. 1/4 of the N. E. 1/4 of Section 10, Township 26 North, Range 29 West.

Description: First opened up in May, 1910. Ore medium hard, dark-red, Non-Bessemer Hematite. Slicing and caving systems of mining are now used. The greatest vertical depth is 300 feet. The ore is shipped via the Minneapolis, St. Paul & Sault Ste. Marie Railway to Superior, Wisconsin, and from there to the lower lake ports by boat.

Operating Company: Iroquois Iron Company, Crosby, Minn.

General Manager: Chester D. Tripp.

Sales Agents: Iroquois Iron Company, Crosby, Minn.

Yearly Shipments:

1910--19111912— 49,539 tons 1913—105,087 tons

Total, Tons......154,626

ARMOUR NO. 2 MINE.

Location: Crow Wing County, Ironton, Minnesota, S. ½ of the N. W. of Section 11, Township 46 North, Range 29 West.

Description: First opened up in May, 1910. Ore medium hard, purplish-red, Non-Bessemer, red, Hematite. Slicing and caving systems of mining are now used. The greatest vertical depth is 258 feet. The ore is shipped via the Minneapolis, St. Paul & Sault Ste. Marie Railway to Superior, Wisconsin, and from there to the lower lake ports by boat.

Operating Company: Iroquois Iron Company, Crosby, Minn.

General Manager: Chester D. Tripp.

Sales Agents: Iroquois Iron Company, Crosby, Minn.

Yearly Shipments:

1910-19111912-49,031 tons 1913-175,665 tons

Total, Tons......224,696

BARROWS MINE.

Location: Crow Wing County, Minnesota, Section 10, Township. 44, Range 31.

Description: First opened up in 1913. Ore is medium hard, red, Non-Bessemer Hematite. Underground stoping system of mining is used. The greatest vertical depth is 150 feet. The ore is shipped via the Northern Pacific Railway to Superior, and thence by boat to lower lake ports. Mine is now idle.

Yearly Shipments:

1913— 9,089 tons

Analysis: The average of all cargo analyses for 1913 is as fol-

lows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 54.90 .452 9.60 .31 3.01 .84 .22 .063 7.49

The ore in its natural state is as follows:

Moist Iron Phos. Silica 13.40 47.54 .391 8.31

KENNEDY MINE.

Location: Crow Wing County, Cuyuna, Minnesota, N. W. ¼ of the S. E. ¼ of Section 30, Township 47 North, Range 28 West.

Description: First opened up in June, 1907. Ore is medium hard, dark-red Non-Bessemer Hematite and some limonite. Slicing and caving systems of mining are now used. The greatest vertical depth is 295 feet; (level at 262 feet). The ore is shipped via the Minneapolis, St. Paul & Sault Ste. Marie Railway to Superior, Wisconsin, and from there to the lower lake ports by boat.

Operating Company: Rogers-Brown Ore Company, Crosby, Minnesota.

General Manager: Chester D. Tripp.

Sales Agents: Rogers-Brown & Company.

Yearly Shipments:

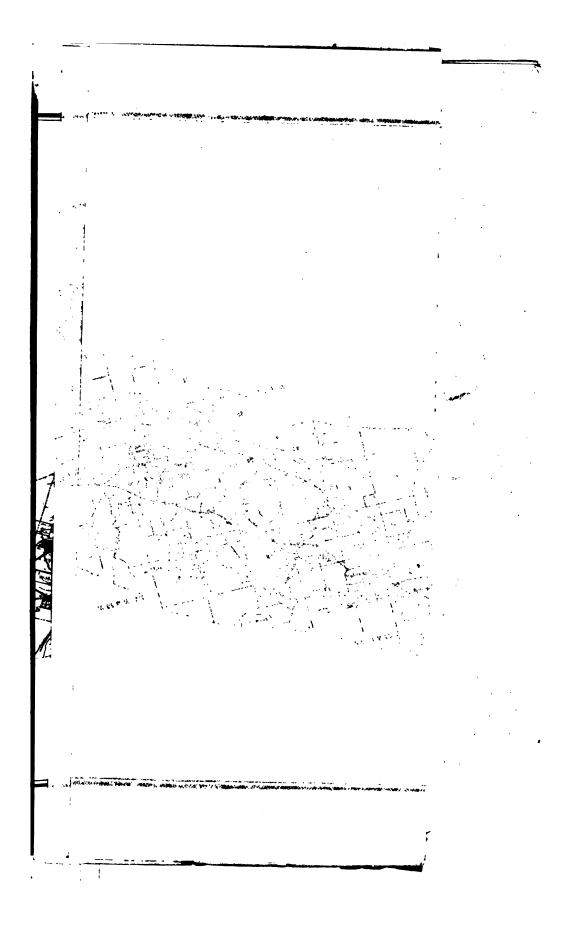
1907— 1911—147,431 tons 1908— 1912—196,653 tons 1909— 1913—

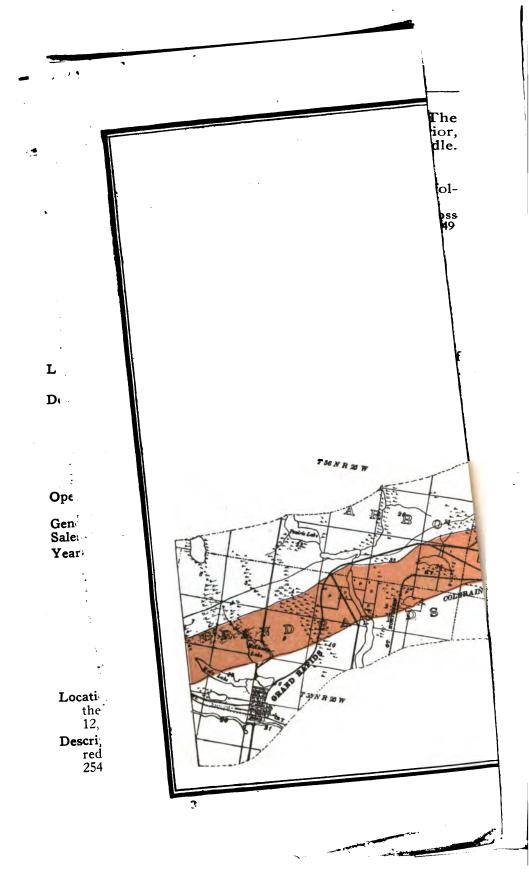
Total, Tons......244,084

MEACHAM MINE.

Location: Crow Wing County, Crosby, Minnesota, N. E. 1/4 of the N. E. 1/4, and N. W. 1/4 of the N. W. 1/4, Sections 11 and 12, respectively, Township 46 North, Range 29 West.

Description: First opened up in May, 1909. Ore medium hard, red, Non-Bessemer Hematite. The greatest vertical depth is 254 feet. The ore is shipped via the Minneapolis, St. Paul &





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Sault Ste. Marie Railway to Superior, Wisconsin, and from there to the lower lake ports by boat.

Operating Company: Rogers-Brown Ore Company, Crosby,

Minnesota.

General Manager: Chester D. Tripp.

Sales Agents: Rogers-Brown & Company.

Yearly Shipments:

1909— 1910— 19111912— 1913—

Total, Tons.....

THOMPSON MINE.

Location: Crow Wing County, Crosby, Minnesota, Section 11, Township 46, Range 29.

Description: First opened up in 1911. This mine ships two ores: HALEY and KEATING, soft, brown, Non-Bessemer Hematite ores. The underground method of mining was started, but the mine is now being stripped. The ore is shipped via the Soo Railway to Superior, and from there by boat to the lower lake ports.

Operating Company: The Inland Steel Company, Chicago, Ill. Yearly Shipments:

1911— 1912— 9,888 tons 1913-

Total, Tons......9,888

GOGEBIC RANGE

ANVIL MINE.

Location: Gogebic County, Michigan, Section 14, Township 47, Range 46.

Description: First opened up in 1887. This mine ships two grades of ore: ANVIL, a soft, red, Bessemer Hematite; and ELLA, a soft, Non-Bessemer Hematite. The ore is not crushed. The mine is worked by the sub-slicing system of mining, the greatest vertical depth being 1,700 feet. The ore is shipped via the C. & N. W. Railway to Ashland, and thence by boat to lower lake ports.

Sales Agents: M. A. Hanna & Co., Cleveland, Ohio.

Yearly Shipments:

```
1887-
      - 10,075 tons
                                            1901- 1,101 tons
1888-
     - 24,676 tons
- 47,000 tons
                                            1902-135,502 tons
                                                  — 11,309 tons
— 45,595 tons
1889-
                                            1903-
1890-45,690 tons
                                            1904
            73 tons
1891
                                             1905
                                                   - 82,118 tons
      - 42,090 tons
                                                   - 79,493 tons
1892-
                                             1906
                                                   - 39,495 tons
- 35,937 tons
1893-
                                             1907-
                                            1908
      - 13,297 tons
1894
1895-
      - 68,064 tons
                                            1909
                                                   - 22.927 tons
1896-
      - 57,483 tons
                                            1910
                                                     7,235 tons
1897-
                                            1911-
                                                        310 tons
                                            1912-
1898— 5,037 tons
                                                   – 56,845 tons
1899-
                                            1913-
1900-
```

Total, Tons......831,352

Analysis: The expected analysis for 1914 is as follows: Dried at 212° F.

Ella:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 59.35 .075 8.70 .38 1.16 .33 .22 .022 4.20 The ore in its natural state is as follows:

Moist Iron Phos. Silica 9.09 53.96 .068 7.91

ASHLAND MINE.

Location: Gogebic County, Michigan, Section 22, Township 47, Range 47.

Description: First opened up in 1884. This mine ships two ores, ASHLAND, a soft, red, Bessemer Hematite; and GLOBE, a soft, red, Non-Bessemer Hematite. Sub-level with top slicing and caving systems of mining are used. The greatest vertical depth is 1,324 feet.

The ore is shipped via the Chicago & Northwestern and the Wisconsin Central Railways to Ashland, and from there by boat to the lower lake ports.

Operating Company: E. A. & J. O. Hayes.

Yearly Shipments:

400-		
1885— 6,741 tons	1900232,961	tons
1886— 74,015 tons	1901—286,399	tons
1887—175,563 tons	1902-301,824	tons
1888—174,183 tons	1903—274,138	tons
1889—257,915 tons	1904—344,102	tons
1890-435,946 tons	1905—409,131	tons
1891—267,439 tons	1906241,841	tons
1892—231,896 tons	1907298,056	tons
1893— 66,067 tons	1908—259,611	tons
1894— 83,020 tons	1909—259,612	tons
1895—126,096 tons	1910—231,506	
1896-91,149 tons	1911—151,478	tons
1897—111,625 tons	1912—211,927	tons
1898—123,208 tons	1913— 2,635	tons
1899-154,615 tons	•	
	Tons5,984,430	

ASTEROID MINE.

Location: Gogebic County, Michigan, Section 13, Township 47, Range 46.

Description: First opened up in 1906. This mine ships two ores: ASTEROID, a soft, red Bessemer ore, and RAMSAY, a soft. red, Non-Bessemer ore. Caving system of mining is used. The greatest vertical depth is 11th level.

The ore is shipped via the Chicago & Northwestern Railway to Ashland, and from there by boat to the lower lake ports.

Operating Company: The Castile Mining Company, Wade Build-

ing, Cleveland, Ohio.

Superintendent: P. S. Williams.

Sales Agents: Oglebay, Norton & Company, Cleveland, Ohio.

Yearly Shipments:

1906— 1907— 1908— 1909—	1910— 1911— 20,5 1912— 70,2 1913— 42,4	40 tons
1909—	1913— 42,4 Total, Tons133,227	1/ tons

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Asteroid:

62.11	.037	8.07	Mang. .52	Alum. 1.17	Lime .13	Magnes. .08	.035	Loss .85
Ramsay: Iron 62.14	Phos.	Silica 6.43	Mang. .46	Alum. 1.56	Lime	Magnes.	Sulph.	Loss 1.41

The ore in its natural state is as follows:

Asteroid:

Moist Iron Phos. Silica 11.65 54.87 .033 7.13

Ramsay:

Moist Iron Phos. Silica 11.53 54.98 .084 5.69

ATLANTIC MINE.

Location: Iron County, Wisconsin, Sections 1 and 12, Township

45, Range 1.

Description: First opened up in 1887. The ore, ARGUS, is a soft, red-brown, Non-Bessemer Hematite, and is not crushed. The mine is worked by underground methods, the greatest vertical depth being 1,208 feet. The ore is shipped via the Soo Line Railroad to Ashland, and thence by boat to lower lake ports.

Operating Company: The Oliver Iron Mining Co., Iron Belt,

Wis.

General Manager: J. H. McLean.

General Superintendent: O. C. Davidson.

Yearly Shipments:

Snipments:	
1887— 1,369 tons	1901—190,135 tons
1888	1902—190,213 tons
1889—	1903—148,385 tons
1890	1904— 77,424 tons
1891—	1905—208,039 tons
1892—	1906— 97,689 tons
1893—	1907— 91,759 tons
1894	1908— 41,465 tons
1895— 70,989 tons	1909—124,845 tons
1896— 60,727 tons	1910— 79,847 tons
1897— 50,307 tons	1911—
1898— 38,058 tons	1912—142,080 tons
1899— 19,964 tons	1913—119,770 tons
1900—135,955 tons	

Total, Tons......1,888,820

Analysis: The average of all cargo analyses for 1913 is as fol-

lows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss

57.41 .066 11.25 .35

The ore in its natural state is as follows:

Moist Iron Phos. Silica 12.72 50.10 .058 9.82

BROTHERTON MINE.

Location: Gogebic County, Michigan, Section 9, Township 47, Range 45 West.

Description: First opened up in 1886. This mine ships two grades of ore: BROTHERTON, a hard, purple, Bessemer

Loss

Hematite; and WALTON, a hard, purple, Non-Bessemer Hematite, neither of which is crushed. The mine is worked by the underground stoping system, the greatest vertical depth being 1,157 feet. The ore is shipped via the C. & N. W. Railway to Ashland, and thence by boat to lower lake ports.

Operating Company: Brotherton Iron Mining Co., Cleveland, Ohio.

Manager: C. H. Munger.

Superintendent: L. M. Hardenburgh.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

```
1886- 8,880 tons
                                            1900-89,804 tons
     - 21,721 tons
- 40,639 tons
                                           1901—103,109 tons
1902— 53,255 tons
1887-
1888-
1889-
                                            1903
                                                  - 94,986 tons
      - 53,267 tons
1890— 80,486 tons
                                            1904
                                                  - 84,870 tons
                                                  -137,351 tons
-147,281 tons
1891-
      - 46.574 tons
                                            1905
                                            1906-
1892-130,833 tons
1893-
      - 18,905 tons
                                            1907—104,224 tons
1894
      - 47,148 tons
                                            1908-
                                                  - 96,776 tons
                                            1909-103,090 tons
1895-
      - 40,567 tons
1896-
     – 50,496 tons
                                            1910-102,626 tons
1897— 46,186 tons
                                            1911-65,015 tons
     - 73,198 tons
                                           1912—148,930 tons
1913— 70,138 tons
1898-
1899— 78.858 tons
                                                  - 70,138 tons
              Total, Tons.....2,139,207
```

Analysis: The average of all cargo analyses for 1913 is as fol-Dried at 212° F. lows:

Brotherton:

Phos. Silica Alum. Lime Magnes. Sulph. Iron Mang. 10.13 .89 .24 61.20 .031 .38 .20 .007 .66 Walton: Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss Iron 60.20 .100 10.29 .36 1.10 .51 .29 .009 1.07

The ore in its natural state is as follows:

Brotherton:

Moist Iron Phos. Silica .028 9.22 9.00 55.69

Walton:

Moist Iron Phos. Silica 10.50 53.88 .089 9.21

CARY MINE.

Location: Iron County, Wisconsin, Sections 26 and 27, Township 46, Range 2 East.

Description: First opened up in 1886. The mine ships three ores: CARY EMPIRE, a hard, reddish-purple, Bessemer Hematite; NIMIKON, a hard, reddish-purple, Non-Bessemer Hematite, and WINDSOR, a hard, purple, Bessemer Hematite. The ore is not crushed. The mine is worked by the underground stoping system, the greatest vertical depth being 1,195 feet. The ore is shipped via the C. & N. W. Railway to Ashland, and thence by boat to lower lake ports.

Operating Company: Odanah Iron Co., Cleveland, Ohio.

Manager: C. H. Munger.

Superintendent: L. M. Hardenburgh.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

ompinents.		
Odanah	1896— 66,975	tons
1886— 13,714 tons	1897— 37,693	tons
1887— 30,475 tons	1898— 43,162	tons
1888— 5,412 tons	1899— 62,524	tons
1889— 13,354 tons	1900—125,984	tons
1890— 1,065 tons	1901—180,215	tons
1891—121,318 tons	1902—136,895	
1892— 6,711 tons	1903— 89,221	
1893— 3,956 tons	1904— 61,860	tons
1894— 2,437 tons	1905—146,414	tons
	1903-140,414	tons
Kakagon	1906—216,992	tons
1886— 18,487 tons	1907—209,407	tons
1887— 52,179 tons	1908— 96,358	
1888— 1,228 tons	1909—224,251	
Cary	1910—205,674	tons
1889— 56,542 tons	1911—120,017	tons
1890—116,203 tons	1912—308,292	tons
1891—121,186 tons	1913—217,349	tons
1892—106,484 tons	Nimikon	
1893— 31,052 tons	1886— 4,105	tons
1894— 47,156 tons	1887— 23,217	
1895— 63,787 tons	1888— 1,313	
	Tons3,391,479	
I Otal,	10113	

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

```
Cary Empire:
                  Silica
                                   Alum.
                                            Lime Magnes. Sulph.
  Iron
          Phos.
                           Mang
                                                                      Loss
                  13.48
  53.40
           .053
                           2.96
                                     .92
                                             .28
                                                       .25
                                                              .010
                                                                      4.53
Nimikon:
                                   Alum.
          Phos.
                                            Lime Magnes.
                                                                      Loss
                  Silica
                           Mang.
                                                             Sulph.
  Iron
  58.90
           .064
                  11.50
                             .39
                                     .97
                                             .41
                                                       .23
                                                              .008
                                                                      2.20
Windsor:
          Phos.
                  Silica
  Iron
                           Mang.
                                   Alum.
                                            Lime Magnes.
                                                             Sulph.
                                                                      Loss
  57.90
                                                                      2.72
           .048
                  12.21
                            .44
                                    1.14
                                             .29
                                                       .23
                                                              .008
  The ore in its natural state is as follows:
```

Cary Empire: Phos. Moist Iron Silica 8.50 48.86 .048 12.33 Nimikon: Moist Iron Phos. Silica 10.50 52.72 .057 10.29 Windsor: Phos. Silica Moist Iron 10.00 52.11 .043 10.98

CASTILE MINE.

Location: Gogebic County, Michigan, Section 10, Township 47, Range 45.

Description: First opened up in 1906. The mine ships two ores: CASTILE, a soft, red, Bessemer Hematite; and MEDINA, a soft, red, Non-Bessemer Hematite. Slicing and caving systems of mining are used. The greatest vertical depth is 14th level. The ore is shipped via the Chicago & Northwestern Railway to Ashland, and from there by boat to the lower lake ports.

Operating Company: The Castile Mining Company, Wade Bldg., Cleveland, Ohio.

Superintendent: P. S. Williams.

Sales Agents: Oglebay, Norton & Company, Cleveland, Ohio.

Yearly Shipments:

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Castile:

Silica Iron Phos. Mang. Alum. Lime Magnes. Sulph. Loss .22 61.50 .040 9.62 .41 .59 .25 .013 .86

Medina: Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss Iron 61.10 .083 9.24 .76 .57 .44 .26 .007 1.19

The ore in its natural state is as follows:

Castile:

Moist Iron Phos. Silica 12.97 53.52 .035 8.37

Medina:

Moist Iron Phos. Silica 12.85 53.25 .072 8.05

COLBY MINE

Location: Gogebic County, Michigan, Section 16, Township 47, Range 46.

Description: First opened up in 1884. This mine ships two ores: COLBY, soft, blue, Bessemer Hematite; and COLBY NO. 2, a soft, blue, Non-Bessemer Hematite. Underground system of mining is used.

The ore is shipped via the Chicago & Northwestern and the Wisconsin Central Railways to Ashland, and from there by boat to the lower lake ports.

Sales Agents: Corrigan, McKinney & Co., Cleveland, Ohio.

Yearly Shipments:

```
1899—103,239 tons
1884--
          1,022 tons
1885-
      - 84,302 tons
-257,432 tons
                                                1900- 32,572 tons
                                                1901-
                                                      - 23,475 tons
- 22,526 tons
1886-
1887-
       -258,518 tons
                                                1902
                                                       - 54,915 tons
1888
       -285,880 tons
                                                1903
      -136,833 tons
-193,038 tons
                                                       - 81,141 tons
- 83,736 tons
1889-
                                                1904
1890-
                                                1905
1891
          9,619 tons
                                                1906
                                                       -113.001 tons
      - 69,968 tons
- 59,346 tons
                                                       - 94,480 tons
- 58,305 tons
1892-
                                                1907-
1893-
                                                1908-
1894
                                                1909-170,095 tons
      - 32,616 tons
1895
                                                1910-194,754 tons
                                                1911— 41,630 tons
1912—245,195 tons
1896-48,492 tons
1897— 22,921 tons
1898-152,875 tons
                                                1913-305,744 tons
               Total, Tons......3,237,670
```

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Colby:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss .043 60.20 7.80 .75 2.45 .60 1.24 .72 .008 Colby No. 2:

Alum. Iron Phos. Silica Mang. Lime Magnes. Sulph. Loss 59.45 .059 7.50 .54 2.15 .90 .80 .007 2.95

The ore in its natural state is as follows:

Colby:

Moist Iron Phos. Silica 10.50 53.88 .038 6.98

Colby No. 2:

Moist Iron Phos. Silica 10.80 53.03 .053 6.69

EUREKA MINE.

Location: Gogebic County, Michigan, Section 13, Township 47, Range 46.

Description: First opened up in 1890. This mine ships three ores: BELMONT, a soft, red, Bessemer Hematite; and EUREKA and RAMSAY, both soft, red, Non-Bessemer Hematites. Slicing and caving systems of mining are used. Greatest vertical depth 16th level.

The ore is shipped via the Chicago & Northwestern Railway to Ashland, and from there by boat to the lower lake ports.

Operating Company: The Castile Mining Company, Wade Bldg., Cleveland, Ohio.

Superintendent: P. S. Williams.

Sales Agents: Oglebay, Norton & Company, Cleveland, Ohio.

```
Yearly Shipments:
          1890— 23,794 tons
1891— 13,907 tons
                                                    1902
                                                    1903
                                                    1904
           1892-10,655 tons
           1893
                - 31,385 tons
                                                    1905
                                                          - 37,525 tons
- 57,904 tons
-122,324 tons
           1894
                - 18,329 tons
                                                    1906
           1895
                 - 26,105 tons
                                                    1907-
           1896-
                                                    1908-
                   4,544 tons
           1897
                                                    1909-
                                                          -115,662 tons
           1898
                                                    1910-
                                                          – 41,611 tons
                                                    1911— 98,609 tons
1912— 65,716 tons
1913— 14,562 tons
           1899
           1900
          1901-
                         Total, Tons...........682,632
              The average of all cargo analyses for 1913 is as fol-
              Dried at 212° F.
    lows:
  Belmont:
              Phos.
                      Silica
                                Mang.
                                         Alum.
                                                  Lime Magnes. Sulph.
                                                                              Loss
     Iron
     61.95
               .051
                       6.65
                                  .62
                                         1.62
                                                   .30
                                                                     .016
                                                                              2.45
                                                             .16
  Eureka:
              Phos.
                      Silica
                                Mang.
                                         Alum.
                                                  Lime Magnes.
                                                                    Sulph.
                                                                              Loss
     Iron
     60.20
               .064
                       8.37
                                  .64
                                         1.13
                                                 .16
                                                              .08
                                                                      .012
                                                                              3.63
  Ramsay:
                      Silica
                                                  Lime Magnes. Sulph.
     Iron
              Phos.
                                         Alum.
                                                                              Loss
                                Mang.
     62.14
               .095
                       6.43
                                 .46
                                         1.56
                                                   .25
                                                              .18
                                                                     .008
                                                                               1.41
     The ore in its natural state is as follows:
  Belmont:
     Moist
             Iron
                    Phos.
                            Silica
     13.66
             53.49
                     .044
                              5.74
  Eureka:
     Moist
                    Phos.
                            Silica
             Iron
     13.19
             52.26
                     .056
                              7.27
  Ramsav:
                    Phos.
     Moist
             Iron
                            Silica
     11.53
             54.98
                     .084
                              5.69
```

GENEVA MINE.

Location: Gogebic County, Michigan, Section 18, Township 47, Range 46.

Description: First opened up in 1903. The ore is soft, reddishbrown, Bessemer Hematite, and is not crushed. The mine is worked by underground methods, the greatest vertical depth being 2,079 feet. The ore is shipped via the C. & N. W. Railway to Ashland, and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Ironwood, Mich. General Manager: J. H. McLean.

General Superintendent: O. C. Davidson.

```
Yearly Shipments:
        1903— 7,108 tons
                                          1909-
        1904-
                                          1910-
        1905-
                                          1911-
                                          1912-
        1906-
        1907-
                                          1913- 31,303 tons
        1908-
                    Total, Tons......38,411
Analysis: The average of all cargo analyses for 1913 is as fol-
   lows: Dried at 212° F.
           Phos. Silica
                         Mang. Alum. Lime Magnes. Sulph. Loss
   Iron
   63.90
           .050
                   5.17
                           .26
   The ore in its natural state is as follows:
   Moist Iron Phos. Silica
```

GERMANIA MINE (HARMONY IRON CO.)

Location: Iron County, Wisconsin, S. ½, S. W. ¼, Section 24 and undivided ¼ N. W. ¼, Section 25, Township 46, Range 2 East.

Description: First opened up in 1883. The mine ships KING ore, a soft, red, Non-Bessemer Hematite. Caving system of mining is used. The greatest vertical depth is 1,675 feet. The ore is shipped via the Chicago & Northwestern and the Minneapolis, St. Paul & Sault Ste. Marie Railways to Ashland, and from there by boat to the lower lake ports.

Yearly Shipments:

10.35

57.29

.045

4.64

Simpinents.	
1885— 5,468 tons	1900— 986 tons
1886— 19,734 tons	1901— 10,358 tons
1887— 61,714 tons	1902— 20,502 tons
1888— 53,918 tons	1903— 2,246 tons
1889—103,169 tons	1904— 23,364 tons
1890— 52,000 tons	1905— 2,973 tons
1891— 22,383 tons	1906— 9,436 tons
1892— 4,283 tons	1907— 19,319 tons
1893— 7,964 tons	1908
1894—	1909— 152 tons
1895	1910— 20,080 tons
1896—	1911—
1897— 1.015 tons	1912— 27,950 tons
1898	1913—
1899— 1,255 tons	
	Tons469,969

IRONTON MINE.

Location: Gogebic County, Michigan, Section 17, Township 47, Range 46.

Description: First opened up in 1886. The mine ships two ores: IRONTON, a soft, red, Bessemer Hematite; and IRONTON

NO. 2, soft, red, Non-Bessemer Hematite. Underground system of mining is used.

The ore is shipped via the Chicago & Northwestern and the Wisconsin Central Railways to Ashland, and from there by boat to the lower lake ports.

Sales Agents: Corrigan, McKinney & Co., Cleveland, Ohio.

Yearly Shipments:

1886	18,424	tons	1900— 25,047	tons
1887	24,762	tons	1901—	
1888	•		1902— 8,555	tons
188 9 —	8,635	tons	1903— 16,875	tons
1890			1904— 23,197	tons
1891—	300	tons	1905— 41,314	tons
1892			1906—106,158	tons
1893—			1907—190,986	tons
1894—	•		1908— 92,932	tons
1895			1909—277,594	tons
1896			1910—109,925	
1897—			1911— 63,359	tons
1898			1912—173,135	tons
1899	7,977	tons	1913—166,123	tons
	T	`otal,	Tons1,361,527	

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Ironton:

Mang. Iron Phos. Silica Alum. Lime Magnes. Sulph. Loss 60.15 .044 7.85 .55 1.29 .68 .009 2.40 .70 Ironton No. 2:

 Iron
 Phos. Silica
 Mang. Alum.
 Lime Magnes.
 Sulph. Loss

 59.50
 .058
 7.45
 .56
 2.05
 .85
 .90
 .008
 2.90

The ore in its natural state is as follows:

Ironton:

Mojst Iron Phos. Silica 10.60 53.74 .039 7.02

Ironton No. 2:

Moist Iron Phos. Silica 10.85 53.00 .052 6.64

MIKADO MINE.

Location: Gogebic County, Michigan, Section 18, Township 47, Range 45 West.

Description: First opened up in 1895. The ore is a hard, red, Non-Bessemer Hematite, and is not crushed. The mine is worked by the underhand stoping system, the greatest vertical depth being 1,131 feet. The ore is shipped via the C. & N. W. Railway to Ashland, and thence by boat to lower lake ports.

Operating Company: The Verona Mining Co., Cleveland, Ohio.

Manager: C. H. Munger.

Superintendent: L. M. Hardenburgh.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

```
Yearly Shipments:
                                                  1905—140,740 tons
1906—154,043 tons
          1895— 4,788 tons
          1896-
                                                  1907—163,891 tons
          1897— 11,397 tons
                                                  1908— 86,617 tons
1909— 99,195 tons
          1898-
          1899-
               - 10,324 tons
          1900— 1,090 tons
1901— 91,846 tons
                                                  1910-52,715 tons
                                                  1911-
                                                  1912-
          1902— 98,834 tons
          1903—108,709 tons
1904— 25,611 tons
                                                  1913— 33,111 tons
                       Total, Tons......1,082,911
Analysis:
             The average of all cargo analyses for 1913 is as fol-
            Dried at 212° F.
    lows:
             Phos. Silica
                              Mang. Alum. Lime Magnes. Sulph.
                                                                          Loss
    Iron
    59.70
             .151
                      8.94
                               .40
                                       1.01
                                                 .92
                                                           .36
                                                                  .009
                                                                           2.68
    The ore in its natural state is as follows:
    Moist Iron Phos. Silica
            51.04
                   .129
    14.50
```

MONTREAL MINE.

Location: Iron County, Wisconsin, Section 33, Township 46, Range 2.

Description: First opened up in 1886. The mine ships three ores: MONTREAL, soft, red granular, Bessemer Hematite; LAWRENCE and HAMILTON, both soft, red granular, Non-Bessemer Hematites. Slicing and caving systems of mining are used. The greatest vertical depth is 25th level. The ore is shipped via the Milwaukee, St. Paul & Sault Ste. Marie Railway to Ashland, and from there by boat to the lower lake ports.

Operating Company: The Montreal Mining Company, Wade Building, Cleveland, Ohio.

Superintendent: F. B. Goodman.

Sales Agents: Oglebay, Norton & Company, Cleveland, Ohio.

Yearly Shipments:

```
1886— 23,013 tons
                                                              1900-107,524 tons
1887— 43.989 tons
                                                              1901-72,945 tons
                                                             1902-136,354 tons
 1888— 38,015 tons
                                                             1903—119,368 tons
1904—164,153 tons
1905—108,334 tons
1889— 42,724 tons
1890-16,828 tons
1891— 70,108 tons
                                                             1906—137,849 tons
1907—156,119 tons
1908—177,006 tons
1909—191,611 tons
1892— 58.728 tons
1893— 34,299 tons
1894— 46,037 tons
1895-138,882 tons
1896—131,531 tons
1897—191,106 tons
1898—270,776 tons
                                                             1910—187,325 tons
1911—153,122 tons
1912—247,772 tons
1913—219,469 tons
1899—153,307 tons
                    Total, Tons......3,438,294
```

The average of all cargo analyses for 1913 is as fol-Dried at 212° F. lows: Montreal: Phos. Silica Alum. Lime Magnes. Sulph. Iron Mang. 62.19 2.70 .044 5.73 .34 1.04 .05 .09 .031 Lawrence: Phos. Silica Alum. Lime Magnes. Sulph. Iron Mang. Loss 60.49 .053 8.00 .41 1.33 .28 .12 .018 3.40 Hamilton: Phos. Iron Silica Mang. Alum. Lime Magnes. Sulph. Loss 60.15 .058 7.43 .52 1.33 .20 .16 4.05 The ore in its natural state is as follows: Montreal: Moist Iron Phos. Silica 9.08 56.54 .040 5.21 Lawrence: Moist Iron Phos. Silica 9.74 54.60 .048 Hamilton: Moist Iron Phos. Silica 9.90 54.20 .052 6.69

NEWPORT MINE.

Location: Gogebic County, Michigan, Section 24, Township 47, Range 47 West.

Description: First opened up in 1886. This mine ships four grades of ore: MELROSE, a soft, red, Bessemer Hematite; MONTROSE, NEW ERA NO. 2, and ELLA, soft, red, Non-Bessemer Hematites. The ore is not crushed. The mine is worked by the sub-slicing system, the greatest vertical depth being 2,200 feet. The ore is shipped via the C. & N. W. Railway to Ashland, and thence by boat to lower lake ports.

Operating Company: The Newport Mining Co., Milwaukee, Wis. Manager: E. L. Cullen.

Sales Agents: M. A. Hanna & Co., Cleveland, Ohio.

Yearly Shipments:

ompin	cure .			
1886—	20,184	tons	1900— 217,201	tons
	75,660			tons
1888	69,145	tons	1902— 141,571	tons
1889—	36,987	tons	1903— 279,905	tons
1890	71,488	tons	1904— 171.931	tons
1891—	105,606	tons	1905— 438,023	tons
1892—	165,965	tons	1906— 549,745	tons
1893	109,718	tons	1907— 551,496	tons
1894—	150,392	tons	1908— 579,390	tons
1895	157,821	tons	1909—1,008,354	tons
1896—	142,369	tons	1910—1,182,324	tons
1897—	150,979	tons	1911— 560,760	tons
1898—	196,953	tons	1912— 973,391	tons
1899	263,711	tons	1913—1,146,730	tons
	T	otal.	Tons9.708.244	

The average of all cargo analyses for 1913 is as fol-Analysis: Dried at 212° F. lows: Melrose: Mang. Alum. Phos. Silica Lime Magnes. Sulph. Iron Loss 61.10 6.92 .043 .32 2.83 .014 2.16 .33 .21 Montrose: Phos. Silica Alum. Iron Mang. Lime Magnes. Sulph. Loss 61.30 .096 5.88 .42 2.82 .50 .23 .014 2.32 New Era No. 2: Lime Magnes. Sulph. Iron Phos. Silica Mang. Alum. Loss 56.93 .081 12.10 .40 3.07 .30 .14 .022 2.50 Ella: Alum. Iron Phos. Silica Mang. Lime Magnes. Sulph. Loss 59.35 .075 8.70 .38 1.16 .022 .33 .22 4.20 The ore in its natural state is as follows: Melrose: Moist Iron Phos. Silica .038 53.99 6.11 11.64 Montrose: Moist Iron Phos. Silica 12.85 53.42 .084 5.12 New Era No. 2: Moist Iron Phos. Silica 12.53 49.80 .071 10.58 Ella: Moist Iron Phos. Silica 9.09 53.96 .068 7.91

NORRIE-AURORA MINE.

Location: Gogebic County, Michigan, Sections 22 and 23, Township 47, Range 47.

Description: First opened up in 1885. This mine ships five grades of ore: AURORA, VAUGHN, NORRIE and NORDALE, soft, reddish-brown, Bessemer Hematites; and NORRIE-NORDEN, a soft, reddish-brown, Non-Bessemer Hematite. The ore is not crushed. The mine is worked by underground methods, the greatest vertical depth being 1,736 feet. The ore is shipped via the C. & N. W. and the Soo Line Railroads to Ashland, and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Ironwood, Mich. General Manager: J. H. McLean.

General Superintendent: O. C. Davidson.

Yearly Shipments:

Pabst 1890— 172,060 tons 1885-130,226 tons 1,103 tons 1891— 1886 17,979 tons 1892— 113.245 tons 1887-19.906 tons 1893— 104,510 tons - 206,074 tons 1888 49,979 tons 1894 1889-96,373 tons 1895— 219,960 tons

```
1896-
            68,984 tons
                                                       1887-
                                                                  159,252 tons
                                                       1888-
                                                                  179,937 tons
           220,496 tons
1897-
           223,891 tons
                                                       1889-
                                                                  199,865 tons
1898-
                                                                  246,695 tons
83,554 tons
319,482 tons
           263,869 tons
239,242 tons
                                                       1890-
1899-
                                                       1891-
1900-
                                                       1892-
1901---
           198,686 tons
                                                       1893-
                                                                  179,028 tons
Norrie
                                                       1894
                                                                  203,152 tons
245,883 tons
187,169 tons
1885
             15,419 tons
           124,844 tons
237,254 tons
412,196 tons
1886-
                                                       1895-
                                                       1896-
1887-
1888
                                                       1897-
                                                                   166,122 tons
           674,394 tons
906,728 tons
758,572 tons
                                                       1898-
                                                                  133,076 tons
1889-
                                                                  170,369 tons
193,111 tons
                                                       1899
1890-
1891-
                                                       1900-
                                                                  223,747 tons
1892-
           985,216 tons
                                                       1901-
1893-
           472,062 tons
                                                       1902-
                                                                  402,981 tons
           621,608 tons
738,480 tons
1894
                                                       Norrie Group
                                                       1903—1,145,711 tons
1904— 831,558 tons
1895
1896
           329,068 tons
           604,281 tons
700,990 tons
714,669 tons
                                                               -1,527,128 tons
-1,245,997 tons
                                                       1905-
1897-
1898-
                                                       1906-
                                                       1907—1,109,085 tons
1899-
        - 666,389 tons
- 660,965 tons
                                                               - 773,243 tons
- 977,054 tons
                                                       1908-
1900-
                                                       1909-
1901-
                                                       1910—1,333,006 tons
1911— 883,910 tons
1912—1,500,732 tons
1902-1.080,032 tons
Aurora
              1,173 tons
4,249 tons
1884---
                                                       1913-1,503,443 tons
1885
             94,553 tons
1886-
                   Total, Tons......29,274,015
```

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Aurora: Iron Phos. Silica 61.69 .037 5.76

Mang. Alum. Lime Magnes. Sulph. Loss .31

Vaughn:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 61.11 .036 6.45 .29

Norrie:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 61.26 .036 6.62 .28

Nordale:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 57.92 .040 11.24 .23

Norrie-Norden:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 61.00 .096 8.37 .37

The ore in its natural state is as follows:

Aurora:

Moist Iron Phos. Silica 11.59 54.53 .033 5.09

Vaughn:

Moist Iron Phos. Silica 11.61 54.02 .032 5.70

Norrie: Iron Phos. Silica Moist 10.89 54.59 .032 5.90 Nordale: Moist Iron Phos. Silica 10.61 51.77 .035 10.05 Norrie-Norden: Silica Moist Iron Phos. .086 7.42 10.75 54.44

OTTAWA MINE (Formerly Odanah Mine).

Location: Iron County, Wisconsin, Section 27, Township 46, Range 2 East.

Description: First opened up in 1886. This mine ships four ores: OTTAWA and OTTAWA MANGANESE, soft, red granular, Bessemer Hematites; and ONTARIO and QUEBEC, soft, red, granular, Non-Bessemer Hematites. Stoping system of mining is used. The greatest vertical depth is 11th level.

The ore is shipped via the Milwaukee, St. Paul & Sault Ste. Marie, and the Chicago & Northwestern Railways to Ashland, and from there by boat to the lower lake ports.

Operating Company: The Montreal Mining Company, Wade Building, Cleveland, Ohio.

Superintendent: F. B. Goodman.

Sales Agents: Oglebay, Norton & Company, Cleveland, Ohio.

Yearly Shipments:

Simplifients:		
1886— 13,71	4 tons	1901—
1887— 30,47	5 tons	1902— 26,141 tons
1888— 5,412	2 tons	1903— 87,929 tons
1889— 13,35	tons tons	1904— 30,420 tons
1890— 1,06	5 tons	1905— 21,986 tons
1891—		1906— 57,219 tons
1892— 6,71	ltons	1907— 46,424 tons
1893— 3,95	ó tons	1908— 33,893 tons
1894— 2,43	7 tons	1909—100,223 tons
1895		1910— 83,389 tons
1896		1911— 44,643 tons
1897		1912—111,396 tons
1898		1913— 50.521 tons
1900		•

Total, Tons...........771,308

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Ottawa: Lime Magnes. Sulph. Iron Phos. Silica Mang. Alum. 57.25 .046 8.07 1.78 1.12 .17 .008 5.76 .26 Ontario: Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 54.45 .060 10.55 3.67 .98 .45 .26 .009 5.05

Quebec:

Phos. Iron Silica Mang. Alum. Lime Magnes. Sulph. Loss 58.50 .059 9.85 1.35 .96 .16 .11 .016 5.25 The ore in its natural state is as follows:

Ottawa:

Moist Iron Phos. 8.92 52.14 .042

Ontario:

Moist Iron Phos. Silica 9.81 49.11 .054 9.52

Quebec:

Iron Phos. Silica Moist vioist 110n 7.80 53.94 .054 9.08

PALMS MINE.

Location: Gogebic County, Michigan, Section 14, Township 47, Range 46.

Description: The ore, NORMAN, is a soft, red, Non-Bessemer Hematite. The mine is worked by the sub-slicing system. The greatest vertical depth is 1,700 feet. The ore is not crushed. The ore is shipped via the C. & N. W. Railway to Ashland, Wisconsin, and thence by boat to lower lake ports.

Operating Company: Dunn Iron Mining Co., Milwaukee, Wis.

Manager: E. L. Cullen.

Sales Agents: M. A. Hanna & Company, Cleveland, Ohio.

Yearly Shipments:

Prior to 1909-1,284,489 tons

1911-1912— 39,552 tons 1913— 88,682 tons

1909-1910-

Total, Tons......1,412,723

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Mang. Alum. Lime Magnes. Sulph. .57 1.10 .60 .50 .020 Phos. Silica Iron 61.35 .096 6.70 The ore in its natural state is as follows:

Moist Iron Phos. Silica .087 9.88 55.29 6.04

PLUMER MINE.

Location: Iron County, Wisconsin, Section 6, Township 45, Range 2.

Description: First opened up in 1912. The ore, PLUMER and KENNAN, are both soft, reddish-brown, Non-Bessemer Hematites. The ore is not crushed. The mine is worked by underground methods. The greatest vertical depth is 1,363 feet. The ore is shipped via the C. & N. W. Railway to Ashland, and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Iron Belt, Wis.

General Manager: J. H. McLean.

General Superintendent: O. C. Davidson.

Yearly Shipments:

1912— 47,578 tons 1913— 51,053 tons

Total, Tons........98,631

Analysis: The average of all cargo analyses for 1913 is as fol-

Dried at 212° F. lows:

Plumer:

Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss Iron

59.79 7.19 .075 .40

Kennan: Phos. Iron Silica Mang. Alum. Lime Magnes. Sulph. Loss 61.11 .082 5.68 .36

The ore in its natural state is as follows:

Plumer:

Moist Iron Phos. 11.84 52.71 .066

Kennan:

Moist Iron Phos. Silica 11.34 54.18 .072

ROYAL MINE.

Location: Gogebic County, Michigan, Section 18, Township 47, Range 46.

Description: First opened up in 1913. The ore, PURITAN-RAND, is a soft, dark, reddish-brown, Bessemer Hematite, and is not crushed. The mine is worked by underground methods. The ore is shipped via the C. & N. W. Railway to Ashland, and thence by boat to lower lake ports.

Operating Company: The Oliver Iron Mining Co., Ironwood, Mich.

General Manager: J. H. McLean.

General Superintendent: O. C. Davidson.

Yearly Shipments:

1913— 10,659 tons

PURITAN MINE (Formerly Ruby Mine).

Location: Gogebic County, Michigan, Section 17, Township 47, Range 46.

Description: First opened up in 1886. The ore is a soft, dark, reddish-brown, Bessemer Hematite, and is not crushed. The mine is worked by underground methods, the greatest depth being 1,647 feet. The ore is shipped via the C. & N. W. Railway to Ashland, and thence by boat to lower lake ports.

The Oliver Iron Mining Co., Ironwood, Operating Company: Mich.

General Manager: J. H. McLean.

General Superintendent: O. C. Davidson.

Yearly Shipments:

```
1900—
1901— 21,788 tons
1886-- 16,388 tons
1887-
      - 45,000 tons
         3,058 tons
9,472 tons
                                             1902-
1888-
                                             1903-
1889-
      - 11,694 tons
                                             1904
                                                       1,259 tons
1890-
                                             1905
1891-
           913 tons
1892-
                                             1906
1893
                                             1907
1894
                                             1908
                                             1909
1895
1896-
                                             1910-
                                                    - 50,019 tons
                                             1911-
1897
                                             1912— 90,683 tons
1913— 64,463 tons
1898
1899-
                Total, Tons......314,737
```

Analysis: The average of all cargo analyses for 1913 is as fol-

Dried at 212° F. lows:

Mang. Alum. Lime Magnes. Sulph. Loss .57 Iron Phos. Silica

62.84 .041 4.79

The ore in its natural state is as follows:

Moist Iron Phos. Silica 11.62 55.53 .036

SUNDAY LAKE MINE.

Location: Gogebic County, Michigan, Section 10, Township 47, Range 45 West.

First opened up in 1885. The mine ships two Description: grades of ore: SUNDAY LAKE, a hard, purple, Bessemer Hematite; and EARL, a hard, purple, Non-Bessemer Hema-The ore is not crushed. The mine is worked by the underhand stoping system, the greatest vertical depth being 1,285 feet. The ore is shipped via the C. & N. W. Railway to Ashland, and thence by boat to lower lake ports.

Operating Company: The Sunday Lake Iron Co., Cleveland, Ohio.

Manager: C. H. Munger.

Superintendent: L. M. Hardenburgh.

Sales agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

```
1885— 1,405 tons
1886— 10,963 tons
1887— 18,137 tons
                                                    1891-64,902 tons
                                                    1892— 56,046 tons
1893— 22,876 tons
                                                    1894— 34,323 tons
1888-
                                                          - 20,970 tons
                                                    1895-
1889-
1890- 6,010 tons
                                                    1896— 89,441 tons
```

```
1906— 86,879 tons
1907—101,899 tons
1908—111,130 tons
1909— 93,712 tons
          1897-45,815 tons
          1898-
                 - 12,526 tons
          1899-
          1900-
                 - 74,097 tons
                                                     1910-115,486 tons
          1901-
                 - 89,997 tons
          1902—144,630 tons
1903— 91,383 tons
1904— 50,625 tons
                                                     1911— 56,096 tons
1912—155,485 tons
                                                     1913—133,475 tons
          1905— 79,209 tons
                        Total, Tons......1,767,517
Analysis: The average of all cargo analyses for 1913 is as fol-
    lows: Dried at 212° F.
  Sunday Lake:
                                                   Lime Magnes. Sulph.
                                                                               Loss
              Phos.
                      Silica
                                Mang.
                                         Alum.
    Iron
                                                                                1.22
                                           .97
                                                    .23
                                                               .18
                                                                       .006
              .029
                      11.64
                                  .40
    59.60
  Earl:
                      Silica
                                Mang.
                                          Alum.
                                                   Lime Magnes. Sulph.
                                                                               Loss
              Phos.
    Iron
                                          1.37
                                                              .28
                                                                                 .83
    59.50
              .060
                      11.66
                                 .34
                                                    .34
                                                                       .008
    The ore in its natural state is as follows:
  Sunday Lake:
                    Phos.
    Moist Iron
     9.50
             53.94
                             10.53
                     .026
  Earl:
                    Phos.
    Moist Iron
                             Silica
     9.00
             54.15
                     .054
                             10.61
```

TILDEN MINE.

Location: Gogebic County, Michigan, Section 15, Township 47, Range 46.

Description: First opened up in 1891. The ore, TILDEN NORDEN, is a soft, dark, reddish-brown, Non-Bessemer Hematite, and is not crushed. The mine is worked by underground methods, the greatest vertical depth being 1,435 feet. The ore is shipped via the C. & N. W. Railway to Ashland, and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Bessemer, Mich. General Manager: J. H. McLean.

General Superintendent: O. C. Davidson.

Yearly Shipments:

p	
1891— 28,415 tons	1903—211,534 tons
1892—233,356 tons	1904—204,581 tons
1893—135,118 tons	1905—188,104 tons
1894—209,077 tons	1906—169,697 tons
1895—418,188 tons	1907—312,496 tons
1896—250,205 tons	1908—111,184 tons
1897—276,890 tons	1909—154,506 tons
1898—287,203 tons	1910 99,937 tons
1899—500,830 tons	1911—138,387 tons
1900—481,909 tons	1912—158,151 tons
1901—446,670 tons	1913— 97,573 tons
1902—468,672 tons	·
Total,	Tons5,582,683

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Tilden Norden:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 59.84 .076 6.51 .79

Tilden Norden No. 2:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 57.61 .055 13.25 .57

The ore in its natural state is as follows:

Tilden Norden:

Moist Iron Phos. Silica 11.88 52.73 .067 5.74

Tilden Norden No. 2:

Moist Iron Phos. Silica 11.12 51.20 .049 11.77

WAKEFIELD MINE.

Location: Gogebic County, Michigan, Section 17, Township 47, Range 45.

Description: First opened up in 1913. This mine ships two ores: ANDREWS and DUANE, both soft, Non-Bessemer Hematites, which are not crushed. The mine is worked by the underground stoping and surface methods, the greatest vertical depth being 150 feet. The ore is shipped via the C. & N. W. Railway to Ashland, and thence by boat to lower lake ports.

Operating Company: The Wakefield Iron Co., Wakefield, Mich.

Manager: James D. Ireland. Superintendent: W. C. Hart.

Sales Agents: M. A. Hanna & Co., Cleveland, Ohio.

Yearly Shipments:

1913— 15,261 tons

Analysis: The expected analysis for 1914 is as follows: Dried at 212° F.

Andrews:

Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss Iron 4.60 .38 1.43 .42 .32 .008 62.50 .069 5.50 Duane: Alum. Lime Magnes. Sulph. Loss Iron Phos. Silica Mang. 58.10 .058 7.38 1.61 1.98 .40 .31 4.24

The ore in its natural state is as follows:

Andrews:

Moist Iron Phos. Silica 12.00 55.00 .061 4.84

Duane:

Moist Iron Phos. Silica 11.00 51.71 .052 6.57

YALE MINE.

Location: Gogebic County, Michigan, Section 16, Township 47, Range 46.

Description: First opened up in 1901. The mine ships three grades of ore: PORTER, a soft, red, Bessemer Hematite; GLYUNA, a soft, red, Non-Bessemer Hematite; and SILI-CIOUS, a soft, red, silicious, Hematite. The ore is not crushed. The mine is worked by the caving system, the greatest vertical depth being 1,780 feet. The ore is shipped via the C. & N. W. and the Soo Line Railroads to Ashland, and thence by boat to lower lake ports.

Operating Company: The Lake Superior Iron & Chemical Co., Bessemer, Mich.

Manager: W. H. Mathews.

Superintendent: W. E. McRandle.

Sales Agents: Oglebay, Norton & Co., Cleveland, Ohio.

Yearly Shipments:

```
    1901—12,836 tons
    1908—14,874 tons

    1902—26,043 tons
    1909—71,458 tons

    1903—46,211 tons
    1910—108,253 tons

    1904—46,860 tons
    1911—154,944 tons

    1905—60,224 tons
    1912—76,772 tons

    1906—56,657 tons
    1913—89,482 tons

    1907—38,010 tons
```

Total, Tons......802,624

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Porter:

1ron 60.34		6.43	Mang. .41			Magnes. .24		Loss 4.79
Glyuna: Iron	Phos.	Silica	Mang.	Alum.	Lime	Magnes.	Sulph.	Loss

From Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 59.50 .065 7.60 .41 2.57 .27 .52 .008 3.60

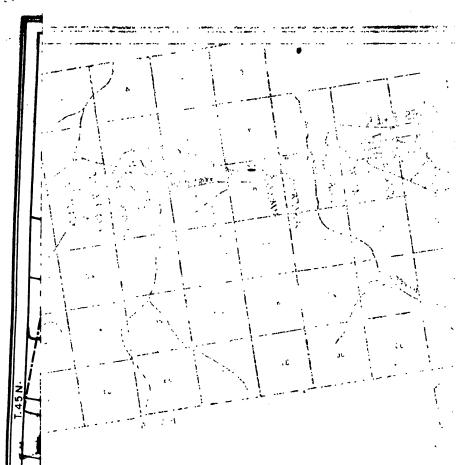
The ore in its natural state is as follows:

Porter:

Moist Iron Phos. Silica 12.93 52.54 .045 5.60

Glyuna:

Moist Iron Phos. Silica 13.50 51.47 .056 6.57

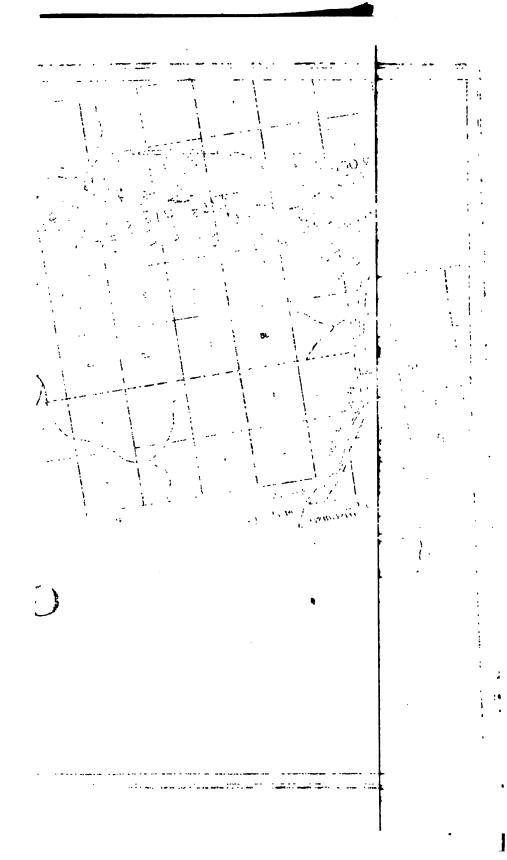


THE SO TAM

OGEBIC RANOF

CROWELL & MERRAY.

dot Large Ryan Paris of g. Creveling & Oldon



MENOMINEE RANGE

ANTOINE MINE (Formerly Traders).

Dickinson County, Michigan, Sections 17 and 20, Location: Township 40 North, Range 30 West.

from this mine, CLIFFORD, a hard, grayish-blue, siliceous **Description:** First opened up in 1895. Bessemer, semi-specular Hematite; and ANTOINE, a grayish-blue, siliceous, Non-Bessemer semi-specular Hematite. Open-pit milling system of mining is used. The greatest vertical depth is 135 feet. The ore is crushed to three-inch size.

The ore is shipped via the Chicago, Milwaukee & St. Paul Railway or the Chicago & Northwestern Railway to Escanaba, and from there to the lower lake ports by boat.

Sales Agents: Oglebay, Norton & Co., Cleveland, Ohio.

Yearly Shipments:

```
1905—138,395 tons
1906—195,855 tons
1907—100,996 tons
1895— 27,931 tons
1896—110,821 tons
1897— 98,847 tons
1898—104,510 tons
1899— 93,025 tons
1900—119,940 tons
                                                           1908-
                                                           1909-
                                                           1910-91,081 tons
                                                           1911- 74,138 tons
1901— 63,429 tons
1902—110,993 tons
1903—107,886 tons
1904— 81,164 tons
                                                           1912-
                                                           1913- 95,310 tons
                   Total, Tons......1,540,183
```

The average of all cargo analyses for 1913 is as fol-Dried at 212° F.

lows:

Clifford: Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss Iron 40.10 .019 38.54 .99 .73 1.12 .10 .90 .011 Antoine:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. .95 38.62 .030 42.13 .15 .59 .75 .017 1.05

The ore in its natural state is as follows:

Clifford:

Analysis:

Moist Iron Phos. Silica 2.90 38.94 .018

Antoine:

Moist Iron Phos. Silica 1.95 37.87 .029 41.31

ARAGON MINE.

Location: Dickinson, Michigan, Sections 8 and 9, Township 39, Range 29.

Description: First opened up in 1899. This mine ships two grades of ore: GRANADA TOWNSITE, a soft, blue, Non-Bessemer Hematite; and CADIZ, a hard, blue, siliceous Hematite. The ore is not crushed. The mine is worked by underground methods, the greatest vertical depth being 1,120 The ore is shipped via the C. & N. W. Railway to Escanaba, and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Norway, Mich. General Manager: J. H. McLean.

General Superintendent: O. C. Davidson.

Yearly Shipments:

```
1902—646,203 tons
1903—522,035 tons
1889— 1,745 tons
                                                   1903—522,035 tons
1904—374,944 tons
1890-46,609 tons
1891— 96,829 tons
1892—167,948 tons
1893—127,901 tons
1894—138,209 tons
1895—183,296 tons
                                                   1905—423,698 tons
1906—431,000 tons
                                                   1907-441,636 tons
                                                   1908-
                                                          -226,354 tons
1896— 95,809 tons
1897—149,594 tons
                                                  1909-
                                                   1909—246,984 tons
1910—241,046 tons
1911—201,187 tons
1898-295,821 tons
1899-337,807 tons
                                                   1912-
                                                          -244,894 tons
1913-230,958 tons
```

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Granada Townsite:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. 59.58 .059 6.31 .16

Cadiz:

Phos. Mang. Alum. Lime Magnes. Sulph. Iron Silica 52.60 .056 16.16 .19

The ore in its natural state is as follows:

Granada Townsite:

Moist Iron Phos. Silica 7.77 54.95 .055 5.82 Cadiz:

Silica Phos. Moist Iron 7.57 48.61 .051 14.93

ARMENIA MINE.

Location: Iron County, Michigan, Section 23, Township 43, Range 32.

Description: First opened up in 1889. The ore is soft, red, Non-Bessemer Hematite. Underground system of mining is used. The ore is crushed.

The ore is shipped via the Chicago & Northwestern and the Chicago, Milwaukee & St. Paul Railways to Escanaba, and from there by boat to the lower lake ports.

Sales Agents: Corrigan, McKinney & Co., Cleveland, Ohio.

Yearly Shipments: 1889- 50,275 tons 1902—100,864 tons 1903— 31,901 tons 1904— 16,577 tons 1890-- 26,649 tons 1891-1905 1892-1906- 27,882 tons 1893 1907— 36,665 tons 1908— 1894 1895---2,045 tons 1909-1896---1910— 65,473 tons 1911— 51,863 tons 1912—150,808 tons 1913— 83,142 tons 1897-1898-1899-1900-1901— 18,750 tons Total, Tons............662,894 Analysis: The average of all cargo analyses for 1913 is as fol-Dried at 212° F. lows: Mang. Alum. Iron Phos. Silica Lime Magnes. Sulph. Loss 57.30 .320 8.56 .58 2.45 1.16 .74 .008 3.85 The ore in its natural state is as follows: Moist Iron Phos. Silica 51.25 10.55 .286 7.65

BAKER MINE.

Location: Iron County, Michigan, Section 31, Township 43,

Range 34.

Description: First opened up in 1909. The ore is soft, red, Non-Bessemer Hematite. Underground system of mining is used. The ore is crushed.

The ore is shipped via the Chicago & Northwestern Railway to Escanaba, and from there by boat to the lower lake ports.

Sales Agents: Corrigan, McKinney & Co., Cleveland, Ohio.

Yearly Shipments:

1909— 45,003 tons 1912— 1910— 39,417 tons 1913— 24,286 tons 1911— 3,290 tons

Total, Tons......111,996

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 56.75 .350 8.24 .55 1.90 1.30 .95 .009 3.90 The ore in its natural state is as follows:

Moist Iron Phos. Silica 8.25 52.07 .321 7.56

BALTIC MINE.

Location: Iron County, Michigan, Section 7, Township 42, Range 34 West.

Description: First opened up in 1901. The ore is a hard, red, Non-Bessemer Hematite, and is crushed. The mine is

worked by the underhand stoping system, the greatest vertical depth being 553 feet. The ore is shipped via the C. & N. W. Railway to Escanaba, and thence by boat to lower lake ports.

Operating Company: The Verona Mining Co., Cleveland, Ohio.

Manager: C. H. Munger.

Superintendent: C. E. Lawrence.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

1901— 17,326 tons	1908—129,037 tons
1902— 64,664 tons	1909—174,426 tons
1903—123,236 tons	1910—171,930 tons
1904—151,114 tons	1911— 66,502 tons
1905—133,246 tons	1912—100,736 tons
1906—186,495 tons	1913—130,631 tons
1907—189.119 tons	

Total, Tons..........1,638,402

Analysis: The average of all cargo analyses for 1913 is as fol-

lows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 54.10 .429 8.27 .36 3.46 1.48 1.58 .072 5.26

The ore in its natural state is as follows:

Moist Iron Phos. Silica 9.50 48.96 .388 7.48

BATES MINE.

Location: Iron County, Michigan, Section 19, Township 43, Range 34.

Description: First opened up in 1910. The ore is medium hard, blue, Hematite. The mine is worked by underground methods, the greatest vertical depth being 450 feet. The ore is shipped via the C. & N. W. and the C. M. & St. P. Railways to Escanaba, and thence by boat to lower lake ports.

Operating Company: Bates Iron Co., Iron River, Mich.

General Manager: F. A. Vogel. Superintendent: Lowe Whiting.

Sales Agents: M. A. Hanna & Co., Cleveland, Ohio.

BENGAL MINE.

Location: Iron County, Michigan, Section 36, Township 43, Range 35.

Description: First opened up in 1913. The ore, BALTIC, is a hard, red, Non-Bessemer, Hematite and is crushed. The mine is worked by the slicing system, the greatest vertical

depth being 280 feet. The ore is shipped via the C. & N. W. Railway to Escanaba, and thence by boat to lower lake ports.

Operating Company: The Verona Mining Co., Cleveland, Ohio.

Manager: C. H. Munger.

Superintendent: C. E. Lawrence.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

1913— 23,259 tons

Analysis: See analysis of BALTIC.

BERKSHIRE MINE.

Location: Iron County, Michigan, Section 6, Township 42, Range 34.

Description: First opened up in 1908. The ore is soft, red, Non-Bessemer Hematite. The caving system of mining is used. The greatest vertical depth is 365 feet.

The ore is shipped via the Chicago & Northwestern Railway to Escanaba, and from there by boat to the lower lake ports.

Operating Company: The Brule Mining Company, Wade Building, Cleveland, Ohio.

General Manager: E. W. Hopkins. Superintendent: Frank J. Smith.

Sales Agents: Oglebay, Norton & Company, Cleveland, Ohio.

Yearly Shipments:

1908— 3,440 tons 1911— 22,273 tons 1909— 34,295 tons 1912— 33,419 tons 1910— 97,999 tons 1913— Total, Tons......191,426

Analysis: The expected analysis for the season of 1914 is as fol-

lows: Dried at 212° F.

 Iron
 Phos. Silica
 Mang. Alum. Lime Magnes. Sulph. Loss 54.10
 .519
 8.18
 .23
 3.82
 3.19
 3.25
 .036
 3.75

The ore in its natural state is as follows:

Moist Iron Phos. Silica 9.85 48.77 .468 7.37

BREEN MINE.

Location: Dickinson County, Michigan, Section 22, Township 39, Range 28.

Description: Re-opened in 1905. The ore, WAUCEDAH, is a soft, red, siliceous Hematite, and is not crushed. The mine is worked by the open-pit milling system, the greatest vertical depth being 223 feet. The ore is shipped via the C. & N. W. Railway to Escanaba, and thence by boat to lower lake ports.

Operating Company: Mineral Mining Co., Iron Mountain, Mich.

Manager: E. F. Brown.

Superintendent: J. A. Monroe.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

Prior to 1887—17,430 tons	1909—
1905— 16,625 tons	1910
1906— 21,004 tons	1911—
1907— 20,366 tons	1912—
1908	1913—
Total, Tons	75,425

Analysis: The expected analysis for season of 1914 is as fol-

lows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 39.00 .016 41.53 .02 .89 .35 .80 .027 .60

The ore in its natural state is as follows:

Moist Iron Phos. Silica 3.00 37.83 .015 40.28

BRISTOL MINE (Formerly Claire Mine).

Location: Iron County, Michigan, Section 19, Township 43, Range 32.

Description: First opened up in 1892. The ore is a hard, brown, Non-Bessemer Hematite. The stoping system of mining is used. The greatest vertical depth is 965 feet. The ore is crushed to 3-inch size.

The ore is shipped via the C. & N. W. and C. M. & St. P. Railways to Escanaba, and from there to the lower lake ports by boat.

Operating Company: The Bristol Mining Company, Wade Building, Cleveland, Ohio.

Manager: E. W. Hopkins. Superintendent: Arvid Bjork.

Sales Agents: Oglebay, Norton & Company, Cleveland, Ohio.

Yearly Shipments:

1913—379,168	tons
Tons3,593,543	
	1903—246,581 1904—132,420 1905—210,388 1906—298,031 1907—345,676 1908—190,300 1909—396,825 1910—270,742 1911—322,647 1912—435,619 1913—379,168 Tons3,593,543

Analysis: The average of all cargo analyses for 1913 is as fol-

lows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 49.68 .582 7.20 3.61 3.46 2.30 1.49 1.03 7.55

The ore in its natural state is as follows:

Moist Iron Phos. Silica 7.16 46.12 .540 6.68

BUCKEYE MINE.

Location: Florence County, Wisconsin, Section 33, Township 40, Range 18.

Description: First opened up in 1909. The ore is a lumpy, red, Non-Bessemer Hematite, and is passed over a grizzly, the lumps being sledged. The mine is worked by underground methods, the greatest vertical depth being 485 feet. The ore is shipped via the C. & N. W. Railway to Escanaba, and thence by boat to lower lake ports.

Operating Company: The Reserve Mining Co., Cleveland, Ohio.

Manager: E. W. Hopkins.

Superintendent: R. A. Bowen.

Sales Agents: Oglebay, Norton & Co., Cleveland, Ohio.

Yearly Shipments:

1910— 89,116 tons 1912— 1911— 1913—

Total, Tons........89,116

Analysis: The expected analysis for 1914 is as follows: Dried at 212° F.

 Iron
 Phos. Silica
 Mang. Alum
 Lime Magnes. Sulph.
 Loss

 53.01
 .395
 10.34
 .14
 3.15
 2.38
 2.75
 .223
 4.72

The ore in its natural state is as follows:

Moist Iron Phos. Silica 7.57 49.00 .365 9.65

CALUMET MINE.

Location: Dickinson County, Michigan, Section 8, Township 41, Range 23.

Description: Re-opened in 1906. The ore is a hard, red, siliceous Hematite and is crushed. The back-stoping system of mining is used. The ore is shipped via the C. & N. W. Railway to Escanaba, and thence by boat to lower lake ports.

Operating Company: Calumet Ore Co., Cleveland, Ohio.

Manager: C. H. Munger.

Superintendent: C. E. Lawrence.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

1909-

1910-1911-

Prior to 1894—38,713 tons 1906— 15,773 tons 1907— 51,646 tons 1908— 15,222 tons 1912— 33,587 tons 1913— 18,976 tons

Total, Tons..........173,917

Analysis: The average of all cargo analyses for 1913 is as fol-

Dried at 212° F. lows:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. 39.50 1.75 .58 1.34 .021 38.68 .25 .70 .012

The ore in its natural state is as follows:

Moist Iron Phos. Silica 37.72 .020 36.39

CARPENTER MINE.

Location: Iron County, Michigan, Section 31, Township 43,

Range 32.

Description: Will be opened up in 1914. The mine will be worked by the underground stoping system. The ore will be shipped via the C. M. & St. P. Railway to Escanaba, and thence by boat to lower lake ports.

Operating Company: The Hollister Mining Co., Crystal Falls,

Mich.

Manager: James D. Ireland. Superintendent: Ira S. Roe.

Sales Agents: M. A. Hanna & Company, Cleveland, Ohio.

Analysis: The expected analysis for season 1914 is as follows:

Dried at 212° F.

Phos. Silica Mang. Alum. Iron Lime Magnes. Sulph. Loss 57.00 2.00 2.09 .88 .600 6.32 .60 .046 4.02

The ore in its natural state is as follows:

Moist Iron Phos. Silica 51.16 .539

CASPIAN MINE.

Iron County, Michigan, Section 1, Township 42, Location:

Range 35.

Description: The mine was first opened up in 1903. The ore, BALTIC, is a hard, red, Non-Bessemer Hematite and is crushed. The mine is worked by the underground slicing system. The greatest vertical depth is 292 feet. The ore is shipped via the C. & N. W. Railway to Escanaba, and thence by boat to lower lake ports.

Operating Company: The Verona Mining Co., Cleveland, Ohio.

Manager: C. H. Munger.

Superintendent: C. E. Lawrence.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

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Yearly Shipments:
```

```
    1903— 2,088 tons
    1909—189,023 tons

    1904— 4,242 tons
    1910—171,334 tons

    1905— 10,248 tons
    1911—165,660 tons

    1906— 80,875 tons
    1912—306,913 tons

    1907—138,867 tons
    1913—295,841 tons

    1908—102,628 tons
```

Total......1,467,719 tons

Analysis: See analysis of BALTIC.

CHAPIN MINE.

Location: Dickinson County, Michigan, Sections 25 and 30, Township 40, Ranges 31 and 30.

Description: First opened up in 1880. Two ores are shipped from this mine: CHAPIN and AJAX, both soft, blue, Non-Bessemer Hematite. The ore is not crushed. The mine is worked by underground methods. The greatest vertical depth is 1,522 feet. The ore is shipped via the C. M. & St. P. Railway to Escanaba, and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Iron Mountain, Mich.

General Manager: J. H. McLean.

General Superintendent: O. C. Davidson.

Yearly Shipments:

Prior to 1909 — 16,596,287 1911—357,598 tons 1909—578,647 tons 1910—465,543 tons 1910—65,543 tons

Total, Tons......18,695,857

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Chapin:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 58.62 .061 6.43 .22

Ajax:

1ron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 52,30 .057 13.64 .23

The ore in its natural state is as follows:

Chapin:

Moist Iron Phos. Silica 6.57 54.77 .057 6.43

Ajax:

Moist Iron Phos. Silica 6.53 48.89 .053 12.75

CHATHAM MINE.

Location: Iron County, Michigan, Section 35, Township 43, Range 35.

Description: First opened up in 1907. The ore is soft, brown, Non-Bessemer Hematite. Underground system of mining is used. The greatest vertical depth is 700 feet. The ore is passed over a grizzly and the lumps are sledged.

The ore is shipped via the Chicago & Northwestern Railway to Escanaba, and from there by boat to the lower lake ports.

Operating Company: The Brule Mining Company, Wade Building, Cleveland, Ohio.

General Manager: E. W. Hopkins.

Superintendent: F. J. Smith.

Sales Agents: Oglebay, Norton & Company, Cleveland, Ohio.

Yearly Shipments:

 1907— 14,833 tons
 1911— 58,056 tons

 1908— 45,826 tons
 1912—134,079 tons

 1909— 68,730 tons
 1913—107,608 tons

 1910— 51,988 tons

Total, Tons......382,170

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 54.29 .343 10.63 .17 1.24 2.10 .76 .15 6.50

The ore in its natural state is as follows:

Moist Iron Phos. Silica 7.11 50.43 .319 9.62

CHICAGON MINE.

Location: Iron County, Michigan, Section 26, Township 43, Range 34.

Description: First opened up in 1911. The ore is a hard and soft, red, Non-Bessemer Hematite. The ore is crushed. The mine is worked by the underground stoping method. The greatest vertical depth is about 510 feet. The ore is shipped via the C. & N. W. and the C. M. & St. P. Railways to Escanaba, and thence by boat to lower lake ports.

Operating Company: Munro Iron Mining Co., Iron River, Mich., and Buffalo, N. Y.

Manager: G. L. Woodworth. Superintendent: D. H. Campbell.

Yearly Shipments:

1911—108,947 tons 1913—137,002 tons 1912—149,619 tons

Total, Tons......395,568

CRYSTAL FALLS MINE.

Location: Iron County, Michigan, Section 21, Township 43,

Description: First opened up in 1882. Now idle. The ore is

soft, brown, Non-Bessemer Hematite, crushed.

Sales Agents: Corrigan, McKinney & Co., Cleveland, Ohio.

Yearly Shipments:

Prior to 1909—1,735,251 tons 1912---1913— 7,389 tons 1910-710 tons 1911-

Total, Tons...........1,744,015

CUNDY MINE.

Dickinson County, Michigan, Section 3, Township Location: 39, Range 30.

Description: First opened up in 1899. The ore, GRAY, is a hard, blue-gray, Non-Bessemer Hematite. The mine is worked by underground methods. The greatest vertical depth is 625 feet. The ore is crushed. The ore is shipped via the C. & N. W. Railway to Escanaba and thence by boat to lower lake ports.

Operating Company: The Oliver Iron Mining Co., Quinnesec, Mich.

General Manager: J. H. McLean.

General Superintendent: O. C. Davidson.

Yearly Shipments:

1896— 3,395 tons 1897— 41,942 tons 1901—178,800 tons 1902—183,052 tons 1898— 76,877 tons 1899—100,903 tons 1903—111,851 tons 1909— 5,512 tons 1913— 2,543 tons 1900-141,148 tons Total, Tons......846,023

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 41.33 .039 26.95

The ore in its natural state is as follows:

Moist Iron Phos. Silica 2.05 40.48 .038

DAVIDSON NO. 1 MINE.

Location: Iron County, Michigan, Section 23, Township 43,

Range 35.

Description: First opened up in 1911. The ore is a soft, yellow, Non-Bessemer, high grade limonite. The greatest vertical depth is 450 feet. The ore is shipped via the Chicago & Northwestern Railway to Escanaba, and from there by boat to the lower lake ports.

Operating Company: Davidson Ore Mining Co., Buffalo, N. Y.

Manager: T. F. Hildreth.

Superintendent: Rudolph Ericson.

Sales Agents: Davidson Ore Mining Co., Buffalo, N. Y.

Yearly Shipments:

19Î1— 45,434 tons 1913—195,448 tons 1912—126,207 tons

Total, Tons......367,089

Analysis: The average of all cargo analyses for 1913 is as fol-

lows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 56.25 .470 5.90 .26 2.12 .40 .36 .074 9.35

The ore in its natural state is as follows:

Moist Iron Phos. Silica 6.90 52.31 .437 5.48

DAVIDSON NO. 2 MINE.

Location: Iron County, Michigan, Section 14, Township 43, Range 35.

Description: First opened up in 1911. The ore is a soft, yellow, Non-Bessemer high grade limonite. The greatest vertical depth is 240 feet. The sub-level caving method of mining is now used.

The ore is shipped via the Chicago & Northwestern Railway to Escanaba, and from there by boat to the lower lake ports.

Operating Company: Davidson Ore Mining Co., Buffalo, N. Y.

Manager: T. F. Hildreth.

Superintendent: Rudolph Ericson.

Sales Agents: Davidson Ore Mining Co., Buffalo, N. Y.

DUNN MINE.

Location: Iron County, Michigan, Section 1, Township 42, Range 33.

Description: First opened up in 1887. The ore is soft, brown, Non-Bessemer Hematite. Underground system of mining is used. The ore is crushed.

The ore is shipped via the Chicago & Northwestern and the Chicago, Milwaukee & St. Paul Railways to Escanaba, and from there by boat to the lower lake ports.

Sales Agents: Corrigan, McKinney & Co., Cleveland, Ohio.

Yearly Shipments:

1887— 24,677 tons	1901
1888—118.096 tons	1902— 2,816 tons
1889—151,828 tons	1903— 5,365 tons
1890—156,963 tons	1904
1891—162,721 tons	1905— 21,051 tons
1892—133,666 tons	1906— 91,476 tons
1893— 58,590 tons	1907—141,992 tons
1894 24,538 tons	1908— 8,829 tons
1895— 90,885 tons	1909—193,396 tons
1896— 47.081 tons	1910—136,144 tons
1897— 31,062 tons	1911—232,093 tons
1898— 49,381 tons	1912—242,304 tons
1899— 7.458 tons	1913— 14,912 tons
1900—	•

Total, Tons......2,147,342

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 57,10 .640 6.65 .66 1.95 2.89 1.35 .009 3.80

The ore in its natural state is as follows:

Moist Iron Phos. Silica 8.10 52.47 .588 6.11

ERNST MINE.

Location: Florence County, Wisconsin, Section 27, Township 40, Range 18.

Description: First opened up in 1912. The ore is soft, red, Hematite. The mine is worked by the milling and stoping systems. The greatest vertical depth is 225 feet. The ore is shipped via the C. & N. W. Railway to Escanabá, and thence by boat to lower lake ports.

Operating Company: Florence Iron Co. of Wisconsin, Florence, Wis.

General Manager: Felix A. Vogel. Superintendent: E. S. Dickinson.

Sales Agents: M. A. Hanna & Company, Cleveland, Ohio.

Analysis: The expected analysis for 1914 is as follows: Dried at 212° F.

 Iron
 Phos. Silica
 Mang. Alum. Lime Magnes. Sulph. Loss

 55.53
 .180
 7.50
 .45
 2.00
 1.25
 1.40
 .100
 4.00

The ore in its natural state is as follows:

Moist Iron Phos. Silica 7.25 51.50 .166 6.95

FAIRBANKS MINE, OR PAINT RIVER MINE.

Location: Iron County, Michigan, Section 20, Township 43, Range 32.

Description: First opened up in 1882. The ore is a soft, red, Non-Bessemer Hematite. Underground system of mining is used. The ore is crushed.

The ore is shipped via the Chicago & Northwestern and the Chicago, Milwaukee & St. Paul Railways to Escanaba and from there by boat to the lower lake ports.

Sales Agents: Corrigan, McKinney & Co., Cleveland, Ohio.

Yearly Shipments:

nts:			
6,515	tons	1898—	
5,873	tons	1899	
11,652	tons	1900— 1,316	tons
2,373	tons	1901—	
13,933	tons	1902— 10,383	tons
10,240	tons	1903— 9,863	tons
12,506	tons	1904— 11,257	tons
32,700	tons	1905— 11,973	tons
62,654	tons	1906— 28,321	tons
45,435	tons	1907— 75,805	tons
18,390	tons	1908—	
•		1909—	
		1910—	
		1911—	
		1912—	
		1913 2,289	tons
	Total,	Tons382,078	
	6,515 5,873 11,652 2,373 13,933 10,240 12,506 32,700 52,654 45,435 18,390	6,515 tons 5,873 tons 11,652 tons 2,373 tons 13,933 tons 10,240 tons 12,506 tons 32,700 tons 52,654 tons 45,435 tons 18,390 tons	6,515 tons 1898— 5,873 tons 1899— 11,652 tons 1900— 1,316 2,373 tons 1901— 13,933 tons 1902— 10,383 10,240 tons 1903— 9,863 12,506 tons 1904— 11,257 32,700 tons 1905— 11,973 32,700 tons 1906— 28,321 45,435 tons 1907— 75,805 18,390 tons 1908— 1910— 1911— 1911—

FLORENCE MINE.

Location: Florence County, Wisconsin, Sections 20 and 21, Township 40, Range 18.

Description: First opened up in 1880. The ore is a soft, red, Non-Bessemer Hematite and is crushed. The mine is worked by the milling and stoping systems. The greatest vertical depth is 700 feet. The ore is shipped via the C. & N. W. Railway to Escanaba, and thence by boat to lower lake ports.

Operating Company: Florence Iron Company of Wisconsin, Florence, Wis.

General Manager: Felix A. Vogel. Superintendent: E. S. Dickinson.

Sales Agents: M. A. Hanna & Company, Cleveland, Ohio.

Yearly Shipments:

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Prior to 1911—2,957,180 tons 1912— 99,682 tons 1911— 95,266 tons 1913— Total, Tons.........3,152,128
```

Analysis: The expected analysis for 1914 is as follows: Dried at 212° F.

Phos. Mang. Alum. Silica Lime Magnes. Sulph. Iron Loss 55.55 .302 5.81 .23 3.26 6.16 The ore in its natural state is as follows:

Moist Iron Phos. Silica 10.59 49.67 .270

FOGARTY MINE.

Location: Iron County, Michigan, Section 1, Township 42, Range 35.

Description: First opened up in 1907. The ore, BALTIC, is a hard, red, Non-Bessemer Hematite. The ore is crushed. The mine is worked by the underground stoping system. Greatest vertical depth is 365 feet. The ore is shipped via the C. & N. W. Railway to Escanaba, and thence by boat to lower lake ports.

Operating Company: The Verona Mining Co., Cleveland, Ohio.

Manager: C. H. Munger. Superintendent: C. E. Lawrence.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

1907— 7,949 tons 1908— 32,560 tons 1911— 67,616 tons 1912— 84,074 tons 1909— 77,356 tons 1913-124,568 tons 1910- 51,071 tons

Total, Tons......445,194

Analysis: See analysis of BALTIC ore.

GENESEE MINE.

Iron County, Michigan, Sections 29, 30 and 31, Location: Township 43, Range 32 West.

Description: First opened up in 1902. The ore is soft, red, Non-Bessemer Hematite. Underground system of mining is used. The ore is crushed.

The ore is shipped via the Chicago & Northwestern and the Chicago, Milwaukee & St. Paul Railways to Escanaba and from there by boat to the lower lake ports.

Sales Agents: Corrigan, McKinney & Co., Cleveland, Ohio.

Yearly Shipments:

1902— 14,455 tons	1908
1903— 61,694 tons	1909— 65,585 tons
1904—132,380 tons	1910— 66,185 tons
1905— 77,370 tons	1911— 25,342 tons
1906— 80,971 tons	1912— 4,284 tons
1907— 38,984 tons	1913—
Total Tons	567 250

Analysis: The expected analysis for 1914 is as follows: Dried at 212° F.

 Iron
 Phos.
 Silica
 Mang.
 Alum.
 Lime
 Magnes.
 Sulph.
 Loss

 57.15
 .640
 7.60
 .50
 1.85
 2.70
 2.65
 .015
 2.20

The ore in its natural state is as follows:

Moist Iron Phos. Silica 8.50 52.29 .586 6.95

GIBSON MINE.

Location: Iron County, Amasa, Michigan, Section 15, Township 44, Range 33.

Description: First opened up prior to 1892. Mine is now closed. Greatest vertical depth is 430 feet. The ore was shipped via the Chicago, Milwaukee & St. Paul Railway to Escanaba and from there to the lower lake ports by boat.

Operating Company: Rogers-Brown Ore Company, 1515 Corn Exchange Bank Building, Chicago, Ill.

Yearly Shipments:

Prior to 1893— 16,357 tons	1911— 57,100 tons
1908— 4,548 tons	1912—
1909— 36,246 tons	1913
1910— 45,202 tons	
Total, Tons	159,453

GREAT WESTERN MINE.

Location: Iron County, Michigan, Section 21, Township 43, Range 32.

Description: First opened up in 1882. The ore is a soft, brown, Non-Bessemer Hematite and is crushed. Underground system of mining is used.

The ore is shipped via the Chicago & Northwestern and the Chicago, Milwaukee & St. Paul Railways to Escanaba and from there by boat to the lower lake ports.

Sales Agents: Corrigan, McKinney & Co., Cleveland, Ohio.

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Yearly Shipments:
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```
587 tons
22,825 tons
1882-
                                              1898- 33,851 tons
                                              1899-43,316 tons
1883-
       - 20,710 tons
                                                    - 98,550 tons
1884
                                              1900-
1885
                                              1901—123,261 tons
       - 22,267 tons
- 23,239 tons
- 21,860 tons
                                              1902— 42,470 tons
1903—100,751 tons
1886-
1887-
1888
                                              1904
                                                     - 68,318 tons
                                              1905-191,265 tons
1889-
       - 38,454 tons
      - 72,546 tons
                                              1906-
1890-
                                                     -311,218 tons
1891- 62,464 tons
                                              1907-234,492 tons
1892
      - 87,487 tons
                                              1908-124,246 tons
1893---
            661 tons
                                              1909-112,747 tons
1894
                                              1910— 80,709 tons
1911— 84,339 tons
1895-
1896-- 14,643 tons
                                              1912— 3,342 tons
                                              1913- 54,465 tons
1897—
```

Total, Tons......2,095,083

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 55.00 .340 8.40 .75 2.90 2.72 2.35 .080 3.30

The ore in its natural state is as follows:

Moist Iron Phos. Silica 8.20 50.49 .312 7.71

GROVELAND MINE.

Location: Dickinson County, Michigan, N. E. 1/4 of S. E. 1/4 and N. E. 1/4 of S. W. 1/4, Section 31, Township 42, Range 29. Description: First opened up in 1901. The ore is a hard, gray, siliceous Hematite. Milling, overhead and underhand stoping systems of mining are used. The greatest vertical depth is 186 feet. The ore is crushed. The ore is shipped via the Chicago, Milwaukee & St. Paul Railway to Escanaba and from there by boat to the lower lake ports. Mine now idle.

Yearly Shipments:

```
      Prior to 1901—1,049 tons
      1907—13,913 tons

      1901—11,444 tons
      1908—9,123 tons

      1902—7,599 tons
      1909—24,933 tons

      1903—1,294 tons
      1910—26,462 tons

      1904—4,737 tons
      1911—31,907 tons

      1905—14,320 tons
      1912—14,320 tons

      1906—1906—1913—9,251 tons
```

Total, Tons......156,032

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

 Iron
 Phos.
 Silica
 Mang.
 Alum.
 Lime
 Magnes.
 Sulph.
 Loss

 40.80
 .031
 30.28
 .79
 1.25
 2.45
 3.27
 .011
 3.78

The ore in its natural state is as follows:

Moist Iron Phos. Silica 3.38 39.43 .029 29.27

HEMLOCK MINE.

Location: Iron County, Michigan, Section 4, Township 44, Range 33.

Description: First opened up in 1889. The ore is hard, red, Non-Bessemer Hematite. The mine is worked by the backstoping method. The greatest vertical depth is 1,015 feet. The ore is crushed. The ore is shipped via the C. & N. W. Railway to Escanaba, and thence by boat to lower lake ports.

Operating Company: Hemlock River Mining Co., Cleveland, Ohio.

Manager: C. H. Munger.

Superintendent: C. E. Lawrence.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

Shipments:	
1889—	1902—123,331 tons
1890—	1903— 79,420 tons
1891— 35,531 tons	1904—136,232 tons
1892— 65,459 tons	1905—124,450 tons
1893— 11,323 tons	1906—106,437 tons
1894—	1907—117,181 tons
1895— 949 tons	1908— 83,834 tons
1896— 94,645 tons	1909—112,481 tons
1897— 96,032 tons	1910—115,407 tons
1898— 69,865 tons	1911—107,752 tons
1899—110,269 tons	1912—126,132 tons
1900— 72,413 tons	1913—110,511 tons
1901—149,966 tons	·

Total, Tons......2,049,640

Analysis: The average of all cargo analyses for 1913 is as fol-

lows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 50.00 .140 7.20 .32 3.37 5.03 4.68 .011 7.51

The ore in its natural state is as follows:

Moist Iron Phos. Silica 2.50 48.75 .136 7.02

HIAWATHA MINE.

Location: Iron County, Michigan, Section 35, Township 43, Range 35 West.

Description: First opened up in 1893, re-opened in 1908. The ore is part hard and part soft, red, Non-Bessemer Hematite and is crushed. The mine is worked by underground stoping methods. The greatest vertical depth is about 760 feet. The ore is shipped via the C. & N. W. and C. M. & St. P. Railways to Escanaba, and thence by boat to lower lake ports.

Operating Company: Munro Iron Mining Co., Iron River,

Mich., and Buffalo, N. Y. Manager: G. L. Woodworth. Superintendent: D. H. Campbell.

Yearly Shipments:

1911—116,736 tons 1912—220,106 tons 1913—160,510 tons Prior to 1908-210,683 tons 1908—138,190 tons 1909—136,739 tons 1910—128,884 tons

Total, Tons......1,111,848

HILLTOP AND VICTORIA MINE.

Location: Iron County, Michigan, Section 22, Township 43, Range 32.

Description: First opened up in 1912. The ore, VICTOR, is a soft, brown, Non-Bessemer Hematite, the lumps being sledged. The mine is worked by underground methods, the greatest vertical depth being 100 feet. The ore is shipped via the C. & N. W. and the C. M. & St. P. Railways to Escanaba, and thence by boat to lower lake ports.

Operating Company: Cuyahoga Mining Co., Cleveland, Ohio. Manager: F. J. Sullivan.

Superintendent: J. H. Grant.

Sales Agents: Lake Erie Ore Co., Cleveland, Ohio.

The expected analysis for season of 1914 is as fol-Dried at 212° F. Analysis:

lows:

Mang. Alum. Lime Magnes. Sulph. Phos. Silica Loss Iron 55.40 .485 5.30 .22 3.09 .50 .023 The ore in its natural state is as follows:

Moist Iron Phos. Silica 4.00 53.18 .465

HOLLISTER MINE.

Location: Iron County, Michigan, Section 13, Township 43, Range 33.

Description: First opened up in 1890, is now abandoned. The ore was soft, red, Non-Bessemer Hematite. The mine was worked by the stoping system. The greatest vertical depth is about 500 feet. The ore was shipped via the C. & N. W. and C. M. & St. P. Railways to Escanaba and thence by boat to lower lake ports.

Operating Company: Hollister Mining Co., Cleveland, Ohio. Sales Agents: M. A. Hanna & Company, Cleveland, Ohio.

Yearly Shipments:

1890 2	,020 to	ons	1909— 25,842	
1891— 1	,057 to	ons	1910— 49,434	tons
1892 1	021 to	ons	1911—	
1893-1906			1912—	
1907— 6	,371 to	ons	1913— 25,251	tons
1908— 10	671 to	ons		
	T	otal,	Tons121,667	

JUDSON MINE.

Location: Iron County, Michigan, Section 13, Township 42, Range 33 West.

Description: First opened up in 1912. The ore is a red, Non-Bessemer Hematite, and is crushed. The mine is worked by underground methods, the greatest vertical depth being 200 feet. The ore is shipped via the C. & N. W. Railway to Escanaba, and thence by boat to lower lake ports.

Operating Company: Judson Mining Co., Crystal Falls, Mich. Manager: M. E. Richards.

Analysis: The expected analysis for season of 1914 is as fol-

lows: Dried at 212° F.

 Iron
 Phos. Silica
 Mang. 25
 Alum. Lime Magnes. Sulph. Loss
 Loss 2.11
 Loss 2.42

The ore in its natural state is as follows:

Moist Iron Phos. Silica 5.70 53.93 .318 6.95

KIMBALL MINE.

Location: Iron County, Michigan, Section 29, Township 43, Range 32.

Description: First opened up in 1906. The ore is a soft, red, Non-Bessemer Hematite. Underground system of mining is used. The ore is crushed.

The ore is shipped via the Chicago & Northwestern and the Chicago, Milwaukee & St. Paul Railways to Escanaba and from there by boat to the lower lake ports.

Sales Agents: Corrigan, McKinney & Co., Cleveland, Ohio.

Yearly Shipments:

1907—	16,224	tons		1911—
1908—				1912—
1909—				1913—
1910—				
		Total,	Tons	16,224

Analysis: The expected analysis for 1914 is as follows: Dried at 212° F.

 Iron
 Phos. Silica
 Mang. Alum.
 Lime Magnes.
 Sulph.
 Loss

 55.95
 .510
 8.56
 .65
 2.63
 2.25
 2.15
 .006
 2.95

The ore in its natural state is as follows:

Moist Iron Phos. Silica 8.40 51.25 .467 7.84

LAMONT MINE.

Location: Iron County, Michigan, Section 20, Township 43, Range 32.

Description: First opened up in 1889. Now idle. The ore is soft, brown, Non-Bessemer Hematite. The mine was worked by underground methods and the ore was crushed. The ore was shipped via the C. & N. W. and C. M. & St. P. Railways to Escanaba, and thence by boat to lower lake ports.

Yearly Shipments:

1889— 12,348 tons	1902— 47,267 tons
1890— 31,139 tons	1903— 43,736 tons
1891— 26,226 tons	1904— 29,393 tons
1892— 42,819 tons	1905— 74,991 tons
1893— 13,777 tons	1906— 89,980 tons
1894— 2,600 tons	1907— 42,090 tons
1895	1908—
1896—	1909—
1897—	1910— 3,183 tons
1898—	1911—
1899— 67,652 tons	1912—
1900— 31,323 tons	1913—
1901—	
Total,	Tons558,524

LINCOLN MINE.

Location: Iron County, Michigan, Section 21, Township 43, Range 32 West.

Description: First opened up in 1891. The ore is a soft, brown, Non-Bessemer Hematite. Underground system of mining is used. The ore is crushed.

The ore is shipped via the Chicago & Northwestern and the Chicago, Milwaukee & St. Paul Railways to Escanaba and from there by boat to the lower lake ports.

Sales Agents: Corrigan, McKinney & Co., Cleveland, Ohio.

```
Yearly Shipments:
                                                   1905- 19,539 tons
          1891— 1,813 tons
                - 26,019 tons
- 8,757 tons
                                                           5,890 tons
          1892-
                                                   1906---
          1893—
                                                   1907-
                                                             714 tons
          1894-1898
                                                   1908-
          1899-43,622 tons
                                                   1909-
                                                           1,657 tons
          1900— 72,959 tons
1901— 19,727 tons
1902— 7,747 tons
                                                   1910---
                                                   1911-
                                                   1912
          1903-15,606 tons
                                                   1913
          1904— 17,577 tons
                        Total, Tons......241,627
Analysis: The expected analysis for 1914 is as follows:
    at 212° F.
                                                Lime Magnes. Sulph. 2.33 2.37 .009
                               Mang. Alum.
    Iron
             Phos. Silica
                                .77
                                        2.83
                                                                            3.14
    56.76
              .469
                      6.20
    The ore in its natural state is as follows:
    Moist Iron Phos. Silica
     8.56
            51.90
                    .428
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LORETTO MINE.

Location: Dickinson County, Michigan, Section 7, Township 39, Range 28.

Description: First opened up in 1892. Three ores are shipped from this mine: RUSSELL and RUSSELL SPECIAL, both soft, blue, Non-Bessemer Hematites; and LORETTO, a soft, blue, Bessemer Hematite. The ores are not crushed. The mine is worked by the top-slicing system. The greatest vertical depth is 800 feet. The ores are shipped via the C. & N. W. Railway to Escanaba, and thence by boat to lower lake ports.

Operating Company: The Loretto Iron Co., 1400 Fulton St., Chicago, Ill.

Manager: J. Ward Amberg, Chicago.

Superintendent: C. H. Baxter, Loretto, Mich.

Sales Agents: M. A. Hanna & Company, Cleveland, Ohio.

Yearly Shipments:

```
1904 54,720 tons
1893— 8,131 tons
                                              1905—118,738 tons
1906—140,390 tons
1907— 99,779 tons
1894— 55,983 tons
1895— 53,160 tons
1896— 34,334 tons
                                              1908— 13.345 tons
1897— 54,104 tons
                                              1909-96,613 tons
1898— 68,447 tons
                                              1910—116,048 tons
1899— 64,824 tons
1900— 61,219 tons.
                                              1911— 18,655 tons
                                              1912—136,045 tons
1901— 54,985 tons
1902—128,300 tons
                                              1913—158,257 tons
1903— 87,939 tons
               Total, Tons......1,624,025
```

Analysis: The average of all cargo analyses for 1913 is as fol-Dried at 212° F. lows: Russell: Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 54.35 .062 8.20 .22 3.11 2.01 3.44 .010 4.77 Russell Special: Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 45.50 20.00 .055 .16 2.63 1.35 3.81 2.33 .005 Loretto: Mang. Alum. 14 2.58 Phos. Silica Lime Magnes. Sulph. Iron Loss 60.50 .024 7.37 .78 The ore in its natural state is as follows: Russell: Moist Iron Phos. Silica 6.93 50.58 .058 7.63 Russell Special: Moist Iron Phos. Silica 7.40 42.13 .051 18.52 Loretto: Moist Iron Phos. Silica 8.57 55.32 .022 6.74

MANSFIELD MINE.

Location: Iron County, Michigan, Sections 17 and 20, Township 43, Range 31.

Description: First opened up in 1890. The ore, CLEAR-FIELD, is a hard, brown, Non-Bessemer Hematite and is not crushed. The mine is worked by underground methods. The greatest vertical depth is 1,517 feet. The ore is shipped via the C. & N. W. Railway to Escanaba and thence by boat to lower lake ports.

Operating Company: The Oliver Iron Mining Co., Crystal Falls, Mich.

General Manager: J. H. McLean.

General Superintendent: O. C. Davidson.

Yearly Shipments:

armbreren.		
1890— 18,303 tons	1903— 51,440	tons
1891— 49,836 tons	1904— 79,163	
1892— 69,259 tons	1905— 38,584	tons
1893— 69,558 tons	1907—183,532	tons
1897— 37,182 tons	1908— 44,633	
1898— 60,739 tons	1909—118,713	tons
1899— 86,607 tons	1910—114,357	tons
1900— 90,155 tons	1911— 54,646	tons
1901— 74,113 tons	1912—	
1902— 31,181 tons	1913—190,503	tons
Total,	Tons1,462,504	

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 55.71 .125 5.21 .290

The ore in its natural state is as follows:

Moist Iron Phos. Silica 11.33 49.40 .111 4.62

McDONALD MINE.

Location: Iron County, Michigan, Section 23, Township 43, Range 32.

Description: First opened up in 1908. Ore soft, brown, Non-Bessemer Hematite. Top slicing and caving systems of mining are used. The greatest vertical depth is 518 feet.

The ore was shipped via the C. & N. W. Railway to Escanaba, and from there by boat to the lower lake ports. Mine is now idle.

Yearly Shipments:

1908		1911—	5,240	tons
1909—	1,144 tons	1912	1,384	tons
1910—	6,022 tons	1913	16,499	tons
	Total,	Tons30,289	-	

MICHIGAN MINE.

Location: Iron County, Michigan, Section 9, Township 44, Range 33.

Description: First opened up in 1893. The ore is MICHIGAN NO. 1, a hard, brown, Non-Bessemer Hematite. The mine is worked by underground methods. The greatest vertical depth is 656 feet. The ore is shipped via the C. & N. W. Railway to Escanaba, and thence by boat to lower lake ports.

Operating Company: The Oliver Iron Mining Co., Amasa, Mich. General Manager: J. H. McLean.

General Superintendent: O. C. Davidson.

Yearly Shipments:

1893	505 tons	1904—
1894—	77 tons	1905— 58,088 tons
1895—	1,071 tons	1906— 146 tons
1896—	•	1907— 39,819 tons
1897	216 tons	1908— 603 tons
1898—		1909
18 99 —		1910— 17,922 tons
1900		1911—
1901—		1912—
1902—	53,272 tons	1913— 27,917 tons
1903—		

Total, Tons......199,636

Analysis: The expected analysis for season of 1914 is as follows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 56.50 .222 4.50 .31 2.74 2.50 2.95 .063 5.20 The ore in its natural state is as follows:

Moist Iron Phos. Silica 9.80 50.96 .200 4.05

MILLIE MINE (Formerly the Hewitt Mine).

Location: Dickinson County, Michigan, Section 31, Township 40, Range 34.

Description: First opened up in 1880. The ore, ALGOMA, is a soft, blue, Bessemer Hematite. The sub-level back-stope and open-cut systems are used in this mine, the greatest vertical depth being 400 feet. The ore is shipped via the C. & N. W. Railway to Escanaba, and thence by boat to lower lake ports.

Operating Company: B. J. Clergue & Associates, Iron Mountain, Mich.

Manager: S. J. McGregor.

Yearly Shipments:

Smpments:	
1881— 4,352 tons	1898— 17,430 tons
1882— 9,500 tons	1899— 15,194 tons
1883— 7.516 tons	1900— 14,922 tons
1884— 7.927 tons	1901— 12,133 tons
1885— 4,627 tons	1902— 25,935 tons
1886— 5,517 tons	1903— 40,860 tons
1887— 1,163 tons	1904—
1888— 11,124 tons	1905—
1889— 12,274 tons	1906— 36,815 tons
1890— 39,232 tons	1907— 18,691 tons
1891— 5,889 tons	1908— 3,322 tons
1892— 6,780 tons	1909— 10,887 tons
1893—	1910—
1894— 13,062 tons	1911— 17,040 tons
1895— 10,924 tons	1912— 1,165 tons
1896— 21,815 tons	1913—
1897— 10,374 tons	
Total,	Tons386,472

MUNRO MINE.

Location: Dickinson County, Michigan, Section 6, Township 39, Range 29 West.

Description: First opened up in 1903. The ore is a hard, red, siliceous Hematite and is crushed. The mine is worked by underground and open-pit methods. The greatest vertical depth is 150 feet.

The ore is shipped via the C. & N. W. Railway to Escanaba and thence by boat to lower lake ports.

Operating Company: Munro Iron Mining Co., Iron River, Mich., and Buffalo, N. Y.

Manager: G. L. Woodworth. Superintendent: D. H. Campbell.

Yearly Shipments:

1903— 8,739 tons 1904— 32,323 tons 1905— 92,183 tons	1910—	23,241 20,022 9,303	tons
1905— 92,183 tons 1906— 47,454 tons 1907— 46,834 tons		20,100	tons
1908— 27,773 tons Total,	Tons346,489	·	

NANAIMO MINE.

Location: Iron County, Michigan, Section 26, Township 43, Range 35.

Description: First opened up in 1882. The ores, BETA and GAMMA, are both soft, red, Non-Bessemer Hematites and are not crushed. The mine is worked by the sub-level caving and stoping methods. The greatest vertical depth is 326 feet. The ore is shipped via the C. & N. W. Railway to Escanaba, and thence by boat to lower lake ports.

Operating Company: Mineral Mining Co., Iron Mountain, Mich.

General Manager: E. F. Brown. Superintendent: J. A. Munroe.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

1882— 2,480 tons	1905— 91,238 tons
1883— 29,221 tons 1884— 37,620 tons	1906— 91,792 tons 1907— 53,778 tons
1886— 5,400 tons	1907— 33,778 tons 1908— 305 tons
1887— 30,460 tons	1909—
1888— 5,744 tons	1910—
1890— 3,441 tons	1911—
1891— 13,200 tons	1912—
1904 9,086 tons	1913—
Total.	Tons373.765

Analysis: The expected analysis for 1914 is as follows: Dried at 212° F.

Gamma:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 50.27 .319 19.29 .07 1.87 .34 .16 .066 5.51 The ore in its natural state is as follows:

Moist Iron Phos. Silica 8.50 46.00 .291 17.65

OSANA MINE (Formerly James).

Iron County, Michigan, Section 23, Township 43, Location: Range 35.

Description: Re-opened in 1906. The ore, JAMES, is a soft, yellow, Non-Bessemer Limonite and is not crushed. The mine is worked by the sub-level caving and stoping methods. The greatest vertical depth is 428 feet. The ore is shipped via the C. & N. W. Railway to Escanaba, and thence by boat to lower lake ports.

Mineral Mining Co., Iron Mountain, Operating Company: Mich.

General Manager: E. F. Brown. Superintendent: J. A. Monroe.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

1907— 2,360 tons 1908— 59,760 tons 1909— 90,851 tons 1911— 50,439 tons 1912— 75,702 tons 1913-188,966 tons 1910— 78,388 tons

Total, Tons......546,466

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 55.25 .428 8.81 .26 1.53 .32 .32 .021 8.72

The ore in its natural state is as follows:

Moist Iron Phos. Silica 8.00 50.83 .393

PENN MINES.

(Including the Cyclops, Norway, West Vulcan, Curry and Brier Hill Mines).

Location: Dickinson County, Michigan, Sections 5, 9, 10 and 11; Township 39, Range 29.

Description: First opened up in 1877. These mines ship five ores: CYCLOPS, a medium hard, blue, Special Bessemer; VULCAN, a medium hard, blue Bessemer; HARPER, a medium hard, blue, Non-Bessemer; JUPITER, a medium hard, brown, siliceous Bessemer; and MARS, a medium-hard, brown, siliceous Non-Bessemer. All ores are Hematites, and none are crushed. The mines are worked by caving and square-set timbering methods, the greatest vertical depth being 1,500 feet. The ore is shipped via the C. & N. W. and the C. M. & St. P. Railways to Escanaba, and thence by boat to lower lake ports.

Operating Company: Penn Iron Mining Co., Vulcan, Mich. Sales Agents: M. A. Hanna & Co., Cleveland, Ohio. Yearly Shipments:

```
Cyclops
1878— 6,028 tons
1879— 46,158 tons
                                                     1885-49,897 tons
                                                     1886- 37,189 tons
                                                     1887- 14,297 tons
 1880— 14,368 tons
1881— 12,644 tons
1882— 18,287 tons
1883— 22,675 tons
                                                     1888
                                                             - 14,693 tons
                                                     1889-
                                                                6,101 tons
                                                     1890-
                                                                7,361 tons
                                                     1891-
                                                            - 10,599 tons
 1884— 24,099 tons
                                                     1892
                                                             - 1,697 tons
                   Total, Tons......286,093
Norway
1878— 7,276 tons
1879— 73,519 tons
1880—198,165 tons
1881—137,077 tons
                                                     1885— 67,741 tons
                                                     1886— 93,878 tons
                                                    1887— 95,726 tons
1888— 87,260 tons
1889— 68,044 tons
 1882—165,547 tons
1883—114,836 tons
1884— 71,710 tons
                                                     1890— 61,717 tons
                                                    1891— 4,089 tons
1892— 44,767 tons
                 Total, Tons......1,291,352
Vulcan
                                                     1885-124,125 tons
                                                    1886—143,930 tons
1887—205,036 tons
1888—129,541 tons
 1877---
           4,593 tons
        - 38,799 tons
- 56,975 tons
 1878-
 1879-
 1880-
        - 86,976 tons
                                                     1889-153,900 tons
 1881— 85,274 tons
1882— 94,042 tons
1883— 79,874 tons
                                                     1890-104,996 tons
                                                     1891— 78,967 tons
1892—179,904 tons
 1884—101,722 tons
                  ·Curry
                                                     1886-
 1879-
        - 12,803 tons
                                                     1887-
 1880-
        - 21,851 tons
                                                     1888
                                                               5,376 tons
                                                     1889-28,722 tons
 1881— 17,534 tons
                                                    1890— 72,162 tons
1891—100,681 tons
        - 13,374 tons
 1882-
 1883— 3,676 tons
1884— 10,079 tons
                                                     1892—125,773 tons
       - 4,897 tons
 1885-
                   Total, Tons......416,928
 Penn Iron Mining Co.
                                                     1903—343,543 tons
Prior to 1893-3,663,027 tons
                                                     1904—141,948 tons
                                                            -423,244 tons
 1893—280,450 tons
                                                     1905-
 1894—175,274 tons
1895—290,622 tons
1896—179,917 tons
                                                     1906—496,582 tons
1907—381,128 tons
                                                     1908—176,211 tons
1909—428,004 tons
1910—344,760 tons
1911—377,026 tons
 1897-
        -237,886 tons
 1898—223,713 tons
1899—229,651 tons
1900—197,606 tons
                                                     1912-429,150 tons
                                                     1913-416,244 tons
 1901-538,126 tons
 1902—273,443 tons
                  Total, Tons......10,067,555
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```
The average of all cargo analyses for 1913 is as fol-
Analysis:
            Dried at 212° F.
   lows:
 Cyclops:
                                    Alum.
    Iron
            Phos. Silica
                            Mang.
                                             Lime Magnes. Sulph.
                                                                     Loss
   61.27
            .014
                    7.96
                              .08
                                     1.31
                                              .67
                                                     1.31
                                                              .038
 Harper:
                   Silica
                                    Alum.
                                             Lime Magnes. Sulph.
   Iron
            Phos.
                            Mang.
                                                                     Loss
    57.25
            .076
                     7.56
                             .18
                                     1.31
                                             2.09
                                                      3.04
                                                              .035
                                                                      3.74
  Vulcan:
            Phos. Silica
                                    Alum.
                                             Lime Magnes. Sulph.
                                                                     Loss
   Iron
                            Mang.
    57.52
            .046
                    7.96
                             .11
                                     1.26
                                             2.20
                                                      2.51
                                                              .024
    The ore in its natural state is as follows:
 Cyclops:
    Moist
           Iron
                 Phos.
                         Silica
                          7.40
     7.08
           56.93
                   .013
  Harper:
                  Phos.
                         Silica
    Moist
           Iron
    5.50
           54.10
                  .072
                          7.14
  Vulcan:
                 Phos.
    Moist
           Iron
                         Silica
     6.60
           53.72
                   .043
                         7.43
```

PEWABIC MINE.

Location: Dickinson County, Michigan, Section 32, Township

40, Range 30.

Description: First opened up in 1887. This mine ships four ores: PEWABIC-GENOA and TOLEDO, both soft, red, silicious Hematites; PEWABIC, a soft, blue, Bessemer Hematite; and WALPOLE, a soft, blue, Non-Bessemer Hematite. The ores are not crushed. The mine is worked by block-caving and sub-level methods. The greatest vertical depth is 941 feet. The ore is shipped via the C. & N. W. Railway to Escanaba, and thence by boat to lower lake ports.

Operating Company: Pewabic Company, Iron Mountain, Mich.

Manager: E. F. Brown.

Ass't Superintendent: W. G. Monroe.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

ormbring.			
1887— 1,740 t	tons	1901—507,786	tons
1888— 900 t	tons	1902—530,291	tons
1889— 9,614 (tons	1903—489,175	tons
1890— 29,931 t	tons	1904—372,791	tons
1891— 68,402 1	tons	1905—533,413	tons
1892—115,273		1906—493,891	
1893—165,745		1907—457,796	
1894-304,010		1908—365,341	
1895—262,551 (1909465,453	tons
1896—273,587 (1910—380,376	tons
1897—279,855 ±	tons	1911—352,608	
1898—305,072 t		1912—279,769	tons
1899—530,129 t		1913—364,176	tons
1900-374,043 (tons		
To	otal, 🤈	Fons8,313,718	

The average of all cargo analyses for 1913 is as fol-Analysis: Dried at 212° F. lows: Pewabic-Genoa: Phos. Silica Mang. Alum. Lime Magnes. Sulph. Iron Loss 38.55 .012 39.61 .11 1.82 .60 1.68 1.15 .009 Toledo: Silica Lime Magnes. Sulph. Iron Phos. Mang. Alum. Loss 48.40 .014 24.40 .10 1.76 1.06 1.92 .017 1.61 Pewabic: Phos. Iron Silica Mang. Alum. Lime Magnes. Sulph. Loss 61.00 .013 7.98 .10 .94 .99 1.50 .007 1.50 Walpole: Silica Mang. Lime Magnes. Sulph. Iron Phos. Alum. Loss 58.25 2.25 1.38 2.48 .069 8.71 .13 1.63 .006 The ore in its natural state is as follows: Pewabic-Genoa: Phos. Moist Iron Silica 5.00 36.62 .011 37.62 Walpole: Moist Iron Phos. Silica 7.50 53.88 .063 8.05

QUINNESEC MINE.

Location: Dickinson County, Michigan, Section 34, Township 40, Range 30.

Description: First opened up in 1878. The ore is a soft, blue siliceous Bessemer Hematite. The ore is crushed.

The ore is shipped via the Chicago & Northwestern and the Chicago, Milwaukee & St. Paul Railways to Escanaba, and from there by boat to the lower lake ports.

Sales Agents: Corrigan, McKinney & Co., Cleveland, Ohio.

Yearly Shipments:

•				
1878— 25,925 t	ons	1896		
1879 41,954	ons	1897—		
1880 52,436 (ons	1898		
1881— 43,711 1	ons	1899	11.049	tons
1882 44,240 (ons	1900	25,967	tons
1883— 21,676		1901		
1884— 16,995 t		1902-	62,531	tons
1885— 14,110 t		1903—	49,708	tons
1886— 13,442		1904		tons
1887— 6.585		1905—		
1888— 2,249		1906—		
1889— 761		1907—		
1890—		1908	1,410	tons
1891—		1909		
1892—		1910	744	tons
1893—		1911—		
1894—		1912—		
1895—		1913		
	otal, Tons	505.056		
	Clai, IUIIS			

Analysis: The expected analysis for 1914 is as follows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 40.60 .030 34.30 .09 1.20 1.40 .95 .008 1.00 The ore in its natural state is as follows:

Moist Iron Phos. Silica 3.20 39.30 .029 33.20

RANDVILLE MINE.

Location: Dickinson County, Michigan, Section 31, Township

42 North, Range 29 West.

Description: The mine is at present an exploration. The ore

is hard, blue siliceous Hematite.

The ore is shipped via the C. M. & St. P. Railway to Es-

canaba and from there by boat to the lower lake ports. Sales Agents: E. N. Breitung & Co., Cleveland, Ohio.

Analysis: The expected analysis for season 1914 is as follows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 42.70 .024 36.24 .15 .42 .40 .25 .006 1.00 The ore in its natural state is as follows:

Moist Iron Phos. Silica 4.00 40.99 .023 34.79

RAVENNA MINE.

Location: Iron County, Michigan, Section 19, Township 43,

Range 32.

Description: First opened up in 1912. The ore is a soft, red, high phosphorus Hematite. Underground stoping method of mining is now used. The ore is crushed. The greatest vertical depth is 350 feet. The ore is shipped via the C. M. & St. P. and C. & N. W. Railways to Escanaba, and from there to the lower lake ports by boat.

Operating Company: The Hollister Mining Co., Crystal Falls, Mich.

Manager: James D. Ireland. Superintendent: Ira S. Roe.

Sales Agents: M. A. Hanna & Co., Cleveland, Ohio.

Yearly Shipments:

1912— 18,301 tons 1913— 70,763 tons Total, Tons......89,064

Analysis: The expected analysis for 1914 is as follows: Dried at 212° F.

 Iron
 Phos.
 Silica
 Mang.
 Alum.
 Lime
 Magnes.
 Sulph.
 Loss

 53.50
 .889
 8.79
 .19
 3.76
 2.94
 1.61
 .035
 3.09

The ore in its natural state is as follows:

Moist Iron Phos. Silica 10.67 47.79 .794 7.85

RIVERTON MINE.

Location: Iron County, Michigan, Sections 1, 35 and 36, Townships 42 and 43, Range 35.

Description: First opened up in 1898. The ore, BARTON, is a hard, yellowish-brown, Non-Bessemer Hematite and is crushed. The mine is worked by underground methods. The greatest vertical depth is 902 feet. The ore is shipped via the C. & N. W. Railway to Escanaba and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Iron River, Mich.

General Manager: J. H. McLean.

General Superintendent: O. C. Davidson.

Yearly Shipments:

```
    1898— 5,009 tons
    1906—161,704 tons

    1899— 13,242 tons
    1907— 90,358 tons

    1900—120,207 tons
    1908— 47,073 tons

    1901—119,860 tons
    1909—171,200 tons

    1902—215,850 tons
    1910— 84,269 tons

    1903— 97,633 tons
    1911—198,589 tons

    1904— 81,543 tons
    1912—177,496 tons

    1905— 82,611 tons
    1913—160,818 tons
```

Total, Tons......2,732,049

Analysis: The average of all cargo analyses for 1913 is as fol-

lows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 56.07 .619 5.19 .19

The ore in its natural state is as follows:

Moist Iron Phos. Silica 7.04 52.12 .575 4.82

ROGERS MINE.

Location: Iron County, Michigan, Section 29, Township 43, Range 34.

Description: First opened up in 1913. The ore is a hard, red, Non-Bessemer Hematite and is crushed. The mine is a new one and on account of the wide formation, the top-slicing method may have to be used, but that question has not yet been determined. The mine is now worked by stoping method. The greatest vertical depth is about 350 feet. The ore is shipped via the C. & N. W. and C. M. & St. P. Railways to Escanaba and thence by boat to lower lake ports.

Operating Company: Munro Iron Mining Co., Iron River, Mich., and Buffalo, N. Y.

Manager: G. L. Woodworth.

Superintendent: D. H. Campbell.

TOBIN MINE.

Location: Iron County, Michigan, Section 30, Township 43, Range 32.

Description: First opened up in 1901. The ore is soft, red, Non-Bessemer Hematite. Underground system of mining is used. The ore is crushed.

The ore is shipped via the Chicago & Northwestern and the Chicago, Milwaukee & St. Paul Railways to Escanaba and from there by boat to the lower lake ports.

Sales Agents: Corrigan, McKinney & Co., Cleveland, Ohio.

Yearly Shipments:

1901 18.957 to:	ons	1908—161,642 tons
1902— 55,238 to		1909-359,668 tons
1903— 54,386 to	ons	1910—235,812 tons
1904—113,669 to		1911—308,457 tons
1905—166,529 to	ns	1912—319,318 tons
1906—235,867 to		1913—154,896 tons
1907—237,781 to	ns	

Total, Tons......2,413,520

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

 Iron
 Phos. Silica
 Mang. Alum. Lime
 Magnes. Sulph. Loss
 Loss

 57.20
 .650
 7.50
 .45
 1.80
 2.95
 2.56
 .018
 2.30

The ore in its natural state is as follows:

Moist Iron Phos. Silica 8.40 52.39 .595 6.87

TULLY MINE.

Location: Iron County, Michigan, Section 36, Township 43, Range 35 West.

Description: First opened up in 1909. The ore is soft, red, Non-Bessemer Hematite. Underground system of mining is used. The ore is crushed.

The ore is shipped via the Chicago & Northwestern Railway to Escanaba and from there by boat to the lower lake ports.

Sales Agents: Corrigan, McKinney & Co., Cleveland, Ohio.

Yearly Shipments:

1910— 2,726 tons 1912— 1911— 8,324 tons 1913— 16,650 tons Total, Tons.......27,700

Analysis: The average of all cargo analyses for 1913 is as fol-

lows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 59.10 .270 7.25 .24 1.70 1.30 .85 .008 3.60 The ore in its natural state is as follows:

Moist Iron Phos. Silica 8.30 54.19 .247 6.64

VIVIAN MINE.

Location: Dickinson County, Michigan, Section 34, Township

40, Range 30 West.

Description: First opened up in 1902. The ore, VIVIAN, is a hard, red siliceous Hematite and is crushed. The mine is worked by the underhand stoping system. The greatest vertical depth is 310 feet. The ore is shipped via the C. M. & St. P. Railway to Escanaba, and thence by boat to lower lake ports.

Operating Company: The Verona Mining Co., Cleveland, Ohio.

Manager: C. H. Munger.

Superintendent: C. E. Lawrence.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

1902— 40,384 tons 1903— 12,122 tons 1904— 81,345 tons 1905— 90,426 tons 1906—122,577 tons 1908— 10,056 tons 1910— 14,827 tons 1911— 5,971 tons 1912— 28,800 tons 1913— 27,177 tons 1907— 48,493 tons

Total, Tons......482,187

WAUSECA MINE (Formerly Konwinski).

Location: Iron County, Michigan, Section 23, Township 43,

Range 35.

Description: First opened up in 1906. The ore, JAMES, is a soft, red, Non-Bessemer Hematite and is not crushed. mine is worked by sub-level caving and stoping methods. The greatest vertical depth is 398 feet. The ore is shipped via the C. & N. W. Railway to Escanaba, and thence by boat to lower lake ports.

Operating Company: Mineral Mining Co., Iron Mountain, Mich.

General Manager: E. F. Brown. Superintendent: J. A. Monroe.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

1910- 78,388 tons 1912— 75,702 tons 1913—188,966 tons 1911— 50,439 tons

. 393,495 Total, Tons...

Analysis: See analysis of JAMES.

YOUNGS MINE.

Location: Iron County, Michigan, E ½, Section 12, Township

42, Range 35.

Description: First opened up in 1905. Ore hard, red, Non-Bessemer Hematite. The milling and underhand stoping systems of mining are used. The greatest vertical depth is 525 feet.

The ore is shipped via the C. & N. W. Railway to Escanaba. and from there by boat to the lower lake ports. Mine now idle. • • ٠.

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MARQUETTE RANGE.

AMERICAN MINE.

Marquette County, Michigan, Section 32, Township Location: 48, Range 28.

Description: This mine was re-opened in 1906. The ore is a soft, red, Bessemer Specular and is crushed. The mine is worked by underground stoping system. The greatest vertical depth is 1,350 feet. The ore is shipped via the D. S. S. & A. and C. & N. W. Railways to Marquette and Escanaba, and from there to the lower lake ports by boat.

Operating Company: The American-Boston Mining Co., Diorite, Mich.

Managers: J. D. Ireland, Gen. Mgr., J. R. Thompson, Local Mgr.

Superintendent: C. J. Calvin.

Sales Agents: M. A. Hanna & Co., Cleveland, Ohio.

Yearly Shipments:

ompinents.	•
1880— 797 tons	1891— 21,604 tons
1881— 4,702 tons	1892— 15,076 tons
1882— 8,006 tons	1893 to 1905—
1883— 3,618 tons	1906— 419 tons
1884— 2,916 tons	1907— 13,764 tons
1885	1908— 23,222 tons
1886—	1909— 90,001 tons
1887— 1,483 tons	1910—163,290 tons
1888— 13,699 tons	1911—194,979 tons
1889— 20,032 tons	1912—133,306 tons
1890— 21,000 tons	1913—162,253 tons

Total, Tons......894,167

The average of all cargo analyses for 1913 is as fol-Analysis:

Dried at 212° F. lows:

Mang. Alum. Lime Magnes. Sulph. Iron Phos. Silica Loss .032 12.70 .18 2.66 .35 57.65 .51 The ore in its natural state is as follows:

Moist Iron Phos. Silica .029 7.98 53.05 11.69

ANGELINE MINE.

Location: Marquette County, Michigan, Section 15, Township 47 North, Range 27 West. It is in the city of Ishpeming.

Description: First opened up in 1864. Two ores are shipped ANGELINE HEMATITE, a soft, red, from this mine. Bessemer Hematite; SOUTH ANGELINE HEMATITE, a soft, red, Non-Bessemer Hematite.

It is an underground mine worked by slicing system. Greatest vertical depth 515 feet.

The mine is operated by Pittsburgh & Lake Angeline Iron Co.

The ore is shipped via the L. S. & I., D. S. S. & A., and C. & N. W. Railways to L. S. & I. docks, Marquette, and from there to the lower lake ports.

Yearly Shipments:

emhmenre.	
1864— 19,500 tons	1889—229,070 tons
1865 20,151 tons	1890—261,681 tons
1866— 24,073 tons	1891—241,605 tons
1867— 46,607 tons	1892—287,517 tons
1868— 26,651 tons	1893—351,973 tons
1869— 39,694 tons	1894—355,453 tons
1870— 53,467 tons	1895—313,555 tons
1871— 33,645 tons	1896—342,251 tons
1872— 35,221 tons	1897—489,685 tons
1873— 43,933 tons	1898—460,333 tons
1874— 30,499 tons	1899—464,988 tons
1875— 30,282 tons	1900—389,128 tons
1876— 22,539 tons	1901—481,574 tons
1877— 19,113 tons	1902—304,125 tons
1878— 28,161 tons	1903—310,950 tons
1879— 25,420 tons	1904—262,486 tons
1880— 14,794 tons	1905—374,183 tons
1881— 18,060 tons	1906—269,116 tons
1882— 14,326 tons	1907—283,373 tons
1883— 27,259 tons	1908—220,410 tons
1884— 86,922 tons	1909—280,298 tons
1885— 93,287 tons	1910—244,923 tons
1886—123,382 tons	1911—188,645 tons
1887—191,120 tons	1912—151,910 tons
1888—223,600 tons	1913—104,357 tons
	Tons8,875,295
-	· · · · · · · · · · · · · · · · · · ·

Analysis: The expected analysis for 1914 is as follows: Dried at 212° F.

Angeline Hematite:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 66.23 .037 3.17

Angeline South Hematite:

Tron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 63.03 .130 5.45

AUSTIN MINE.

Location: Marquette County, Michigan, Section 20, Township 45, Range 25.

Description: This mine was first opened up in 1903. The ore shipped from this mine is of three grades: AUSTIN BESSEMER, a Bessemer Hematite; AUSTIN and AUSTIN NO. 2, Non-Bessemer Hematites. The ore is not crushed. The mine is worked by the caving system. The greatest vertical depth is 360 feet. The ore is shipped via the M. M. & S. E. and the C. & N. W. Railways to Presque Isle and Escanaba, and thence by boat to lower lake ports.

Operating Company: Cleveland Cliffs Iron Co., Ishpeming, Mich.

Manager: M. M. Duncan.

Superintendent: G. R. Jackson.

Sales Agents: Cleveland Cliffs Iron Co., Cleveland, Ohio.

Yearly Shipments:

Prior to 1909—307,179 tons 1911—105,078 tons 1909—125,858 tons 1912—102,530 tons 1910—188,588 tons 1913—107,366 tons Total, Tons......936,629

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Austin:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 60.80 .086 8.95 .52 .71 .88 .28 .012 .95 The ore in its natural state is as follows:

Moist Iron Phos. Silica 14.00 52.29 .074 7.70

BESSIE MINE.

Location: Marquette County, Michigan, Section 35, Township 48, Range 29.

Description: First opened up in 1890. Ore is a soft, brown, Non-Bessemer Hematite and Limonite.

Mine is shut down at present. Greatest vertical depth 200 feet.

The ore is shipped via the D. S. S. & A. Railway to Marquette, Mich., and from there by boat to the lower lake ports.

Sales Agents: John M. Longyear, Marquette, Mich.

Yearly Shipments:

 1891—
 847 tons
 1904—

 1892 to 1901—
 1905— 21,879 tons

 1902—
 5,007 tons
 1906— 1,646 tons

 1903—
 29,718 tons

Total, Tons......59,097

BREITUNG HEMATITE NO. 1.

Location: Marquette County, Michigan, N. W. 1/4, S. W. 1/4 of Section 8, Township 47 North, Range 26 West.

Description: First opened up in 1901. Four ores are shipped from this mine, FOLEY and FOLEY NO. 2, soft, red and blue, low phosphorous Bessemer Hematites; BREITUNG SILICIOUS, and HEMATITE SILICIOUS, semi-hard, red and blue, Bessemer Silicious Hematites.

The mine is worked by the caving system. Greatest vertical depth 367 feet.

The ore is shipped via the D. S. S. & A. and C. & N. W. Railways to Marquette and Escanaba and from there by

```
boat to the lower lake ports.
    The mine was shut down from 1903 to 1909. Re-opened in
    1909.
Operating Company: Breitung Hematite Mining Co.
Manager: E. N. Breitung, 11 Pine St., New York, N. Y.
Superintendent: W. B. Pattison, Negaunee, Mich.
Sales Agents: E. N. Breitung & Co., Cleveland, Ohio.
Yearly Shipments for Breitung Hematite Nos. 1 and 2.
                                              1909-129,673 tons
         1903---
                 7,854 tons
         1904—
1905—
                                              1910—114,202 tons
1911—139,582 tons
1912—122,320 tons
1913—104,757 tons
                 9,869 tons
         1906- 38,671 tons
         1907— 59,667 tons
1908— 55,849 tons
                      Total, Tons......782,444
            The average of all cargo analyses for 1913 is as fol-
Analysis:
            Dried at 212° F.
    lows:
  Foley:
            Phos.
                                    Alum.
                                             Lime Magnes. Sulph.
                   Silica
                            Mang.
                                                                     Loss
    Iron
    63.02
             .024
                     6.55
                              .13
                                     2.29
                                              .40
                                                              800.
                                                                       .83
  Foley No. 2:
    Iron
            Phos.
                   Silica
                             Mang.
                                    Alum.
                                             Lime Magnes. Sulph.
                                                                     Loss
    56.00
                    16.06
                              .12
                                     2.75
                                                              .010
                                                                      1.00
             .020
                                              .44
                                                       .20
  Breitung Silicious:
                            Mang.
                   Silica
                                    Alum.
                                             Lime Magnes. Sulph.
                                                                     Loss
    Iron
            Phos.
                                                                       .92
    44.11
             .017
                    33.80
                              .08
                                     2.82
                                              .37
                                                       .23
                                                              .012
  *Hematite Silicious:
            Phos.
                   Silica
                                    Alum.
                                             Lime Magnes. Sulph.
    Iron
                            Mang.
                                                                     Loss
    43.00
             .033
                    34.00
                              .84
                                     2.24
                                             1.68
                                                       .12
                                                              .008
                                                                      1.58
    The ore in its natural state is as follows:
```

Moist Iron Phos. Silica 9.41 57.09 .022 5.93

Foley No. 2:

Foley:

Moist Iron Phos. Silica 10.70 50.01 .018 14.34

Breitung Silicious:

Moist Iron Phos. Silica 8.63 40.31 .016 30.88

*Hematite Silicious:

Moist Iron Phos. Silica 6.00 40.42 .031 31.96 Expected analysis, season of 1914.

BREITUNG HEMATITE NO. 2.

Location: Marquette County, Michigan, S. E. 1/4, N. W. 1/4 of Section 8, Township 47 North, Range 26 West.

Description: First opened up in 1902. Two ores shipped from this mine, MARY and CHARLOTTE, soft, red, Non-Bessemer Hematites.

The mine is worked by the caving system. Greatest vertical

depth 369 feet.

The ore is shipped via the D. S. S. & A. and C. & N. W. Railways to Marquette and Escanaba and from there by boat to the lower lake ports.

Operating Company: Breitung Hematite Mining Co.

Manager: E. N. Breitung, 11 Pine St., New York, N. Y.

Superintendent: W. B. Pattison, Negaunee, Mich. Sales Agents: E. N. Breitung & Co., Cleveland, Ohio.

For Shipments see Breitung No. 1.

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Mary:

 Iron
 Phos. Silica
 Mang. Alum.
 Lime Magnes. Sulph.
 Loss

 58.39
 .096
 8.96
 .22
 2.86
 .82
 .92
 .108
 2.09

Charlotte:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 54.27 .085 14.91 .26 2.62 .82 .88 .132 2.00 The ore in its natural state is as follows:

Mary:

Moist Iron Phos. Silica 14.27 50.06 .082 7.68

Charlotte:

Moist Iron Phos. Silica 13.08 47.18 .073 12.96

CAMBRIA MINE.

Location: Marquette County, Michigan, Section 35, Township 48, Range 27.

Description: First opened up in 1875. The ore is a semi-hard, brown, Non-Bessemer Hematite, and is not crushed. The mine is worked by the stoping and subbing systems. Greatest vertical depth is 1,160 feet. The ore is shipped via the C. & N. W. and the D. S. S. & A. Railways to Marquette and Escanaba, and thence by boat to lower lake ports.

Operating Company: Republic Iron & Steel Co., Youngstown, Ohio.

Sales Agents: M. A. Hanna & Company, Cleveland, Ohio.

Yearly Shipments:

1875— 2,610 tons	1895— 41,656 tons
1876— 6,329 tons	1896— 95,086 tons
1877— 10,085 tons	1897—110,648 tons
1878— 3,754 tons	1898—102,623 tons
1879— 6,724 tons	1899—124,930 tons
1880 6,958 tons	1900 80,432 tons
1881— 19,246 tons	1901— 68,907 tons
1882— 64,545 tons	1902— 63,976 tons
1883— 47,508 tons	1903— 41,168 tons
1884— 59,742 tons	1904— 84,852 tons
1885— 50,796 tons	1905— 81,791 tons
1886— 58,784 tons	1906— 40,628 tons
1887— 41,136 tons	1907—135,145 tons
1888— 57,865 tons	1908— 85,977 tons
1889— 72,780 tons	1909—136,815 tons
1890— 80,359 tons	1910—150,422 tons
1891— 34,662 tons	1911— 90,316 tons
1892— 41,549 tons	1912— 69,904 tons
1893— 30,445 tons	1913—169,473 tons
1894— 47,218 tons	•
. m . 1 m	0.517.040

Total, Tons......2,517,842

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

 Iron
 Phos.
 Silica
 Mang.
 Alum.
 Lime
 Magnes.
 Sulph.
 Loss

 57.00
 .110
 10.40
 .21
 2.80
 .76
 .42
 .014
 3.50

The ore in its natural state is as follows:

Moist Iron Phos. Silica 11.50 50.45 .097 9.20

CHAMPION MINE.

Location: Marquette County, Michigan, Sections 31 and 32, Township 48, Range 29.

Description: First opened up in 1867. Ore is No. 1 Lump, a hard, blue, Non-Bessemer Hematite.

It is an underground mine. Greatest vertical depth, 2,292 feet.

The ore is shipped via the C. & N. W. and C. M. & St. P. Railways to Escanaba and from there by boat to the lower lake ports.

The mine is operated by the Oliver Iron Mining Co.

Yearly Shipments:

```
1891—133,413 tons
1892—109,979 tons
1893— 61,648 tons
1867-
            500 tons
1868-
          6.225 tons
1869-
      - 19,458 tons
       - 73,161 tons
1870-
                                                1894— 42.788 tons
                                                1895-
                                                      -100,398 tons
1871-
       - 41,625 tons
       - 68,405 tons
- 72,782 tons
                                                1896—113,375 tons
1897—141,728 tons
1872-
1873-
       - 46.769 tons
1874
                                                1898-
                                                       -163.190 tons
1875
       - 57,979 tons
                                                1899-
                                                       –215,074 tons
1876
       - 66.002 tons
                                                1900—113,743 tons
       - 70,883 tons
1877-
                                                1901-
                                                       - 69,026 tons
1878-
       - 73.464 tons
                                                1902-205.721 tons
1879— 94,027 tons
1880—112,401 tons
1881—145,427 tons
                                                1903-74,238 tons
                                                1904
                                                             174 tons
                                                1905-
                                                       - 64,680 tons
1882-159,009 tons
                                                1906—145,007 tons
1883—104,960 tons
1884—210,180 tons
                                                1907—107,577 tons
1908— 313 tons
1885—173,915 tons
                                                1909-11,199 tons
1886-137,593 tons
                                                1910-18,746 tons
```

Total, Tons......4,413,331

1911-1912-1913-

CHASE MINE.

Location: Marquette County, Michigan, Section 3, Township 47, Range 28.

Description: First opened up in 1910. The ore is a hard, Non-Bessemer Hematite and is crushed. The mine is worked by the caving and shrinkage-stope systems. The greatest vertical depth is 350 feet. The ore is shipped via the L. S. & I. Railway to Escanaba, and thence by boat to lower lake ports.

Operating Company: The Cleveland Cliffs Iron Co., Ishpeming, Mich.

Manager: M. M. Duncan.

Superintendent: W. W. Groff.

1887—146,330 tons 1888—174,680 tons 1889—215,098 tons

1890-223,442 tons

Sales Agents: The Cleveland Cliffs Iron Co., Cleveland, Ohio.

Yearly Shipments:

1910— 1912— 1913— 52,930 tons
Total, Tons......52,930

Analysis: The average of all cargo analyses for 1913 is as fol-

lows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 57.36 .296 7.84 .29 3.15 1.01 .35 .011 4.38 The ore in its natural state is as follows:

Moist Iron Phos. Silica 6.50 53.63 .277 7.33

CLIFF SHAFT MINE.

Location: Marquette County, Michigan, Sections 9 and 10. Township 47, Range 27.

Description: First opened up in 1887. Two ores are shipped from this mine, CRUSHED CLIFF SHAFT and LUMP CLIFF SHAFT, both hard, red, Non-Bessemer, Specular. The ore is crushed and screened.

It is worked as an open, over hand, stoping mine. The pillars are left. Greatest vertical depth 736 feet.

The ore is shipped via the L. S. & I., C. & N. W., and D. S. S. & A. Railways to Presque Isle and Escanaba and from there by boat to the lower lake ports.

Operating Company: The Iron Cliffs Co., Ishpeming, Mich.

Manager: M. M. Duncan. Superintendent: Lucian Eaton.

Sales Agents: Cleveland Cliffs Iron Co., Cleveland, Ohio.

Yearly Shipments:

```
Cliff Shaft
                                             1892—289,395 tons
1893—130,812 tons
 1887— 87,346 tons
1888— 78,520 tons
 1889-134,616 tons
                                              1894-253,760 tons
                                              1895-259,042 tons
 1890—188,776 tons
 1891-278,270 tons
                       Cleveland Cliffs Group
 Prior to 1888-3,704,954 tons
                                             1901—
                                                     860,484 tons
 1888— 184,316 tons
                                            1902-1,104,864 tons
      - 274,048 tons

- 331,713 tons

- 221,788 tons
1889-
                                                   - 810,845 tons
                                             1903
1890---
                                            1904-
                                                   - 743,263 tons
1891-
                                                   -1,288,416 tons
-1,330,944 tons
                                             1905-
1892-
         310,907 tons
                                            1906-
1893
         348,917 tons
                                                  -1,030,928 tons
                                             1907-
        797,466 tons
1894-
                                            1908-
                                                     438,379 tons
         480,195 tons
1895
                                                  - 877,433 tons
- 955,374 tons
                                            1909-
1896-
        513,119 tons
                                            1910-
1897— 718,408 tons
                                            1911—1,344,950 tons
1898— 869,482 tons
                                            1912-1,004,684 tons
1899-1,011,048 tons
                                            1913— 997,520 tons
1900— 881,021 tons
```

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Crushed Cliff Shaft:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 59.02 .105 5.33 .61 2.45 1.65 1.19 .013 2.66 Lump Cliff Shaft: Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 60.21 .099 4.76 .61 2.41 1.37 .91 .014 2.31 The ore in its natural state is as follows:

Crushed Cliff Shaft:

Moist Iron Phos. Silica 1.25 58.28 .104 5.26 Lump Cliff Shaft: Moist Iron Phos. Silica .50 59.91 .098 4.74

EMPIRE MINE.

Location: Marquette County, Michigan, Section 19, Township

47, Range 26.

Description: First opened up in 1907. The ore is a hard, red, silicious Hematite and is crushed to two-inch size. It is an open-pit milling mine. Greatest vertical depth 200 feet. The ore is shipped via the C. & N. W. Railway to Escanaba, Michigan, and from there by boat to the lower lake ports.

Operating Company: Empire Iron Company, Rector Bldg., Chicago, Illinois.

Manager: E. W. Hopkins.

Superintendent: F. D. Klinglund.

Sales Agents:. Oglebay, Norton & Company, Cleveland, Ohio. Yearly Shipments:

> 1907— 40,565 tons 1908— 53,537 tons 1909—108,993 tons 1911— 17,117 tons 1912— 32,933 tons 1913— 38,534 tons 1910— 53,687 tons Total, Tons......345,366

The average of all cargo analyses for 1913 is as fol-Dried at 212° F.

lows:

Phos. Silica Iron Mang. Alum. Lime Magnes. Sulph. 40.09 .078 41.01 .02 1.12 .35 .20 .037 1.50 The ore in its natural state is as follows:

Moist Iron Phos. Silica 39.08 .076 39.97

GWINN MINE (Formerly Smith).

Marquette County, Michigan, Section 28, Township Location:

45, Range 25.

Description: First opened up in 1907. This mine ships two grades of ore; GWINN BESSEMER, and GWINN NON-BESSEMER, both Hematites. The ore is not crushed. The mine is worked by the caving system. The greatest vertical depth is 1,010 feet. The ore is shipped via the M. M. & S. E. and the C. & N. W. Railways to Presque Isle and Escanaba, and thence by boat to lower lake ports.

Operating Company: The Cleveland Cliffs Iron Co., Ishpeming, Mich.

Manager: M. M. Duncan.

Superintendent: G. R. Jackson.

Sales Agents: The Cleveland Cliffs Iron Co., Cleveland, Ohio. Yearly Shipments:

1911--197 tons 1913-1912-

HARTFORD MINE.

Location: Marquette County, Michigan, Section 36, Township

48, Range 27.

Description: First opened up in 1889. There are two ores shipped from this mine, BERNHART and AVERHART, hard, brown, Non-Bessemer Hematites.

The mine is worked by the stoping system. Greatest vertical

depth 1,075 feet.

The ore is shipped via the C. & N. W. and D. S. S. & A. Railways to Escanaba and Marquette and from there by boat to the lower lake ports.

The mine is operated by the Republic Iron & Steel Co.,

Youngstown, Ohio.

Sales Agents: M. A. Hanna & Co., Cleveland, Ohio.

Yearly Shipments:

Janapine.		,
1889—	566 tons	1901—
1890		1902— 7,440 tons
1891—		1903— 20,085 tons
1892	5,678 tons	1904—179,980 tons
	6,513 tons	1905—322,209 tons
1894—	940 tons	1906—364,801 tons
1896—	1,532 tons	1907—328,161 tons
1897—	•	1908—278,366 tons
1898—		1909—250,680 tons
1899—		1910—183,471 tons
1900—		,

Total, Tons..........1,950,422

LAKE MINE.

Location: Marquette County, Michigan, Section 10, Township

47, Range 27.

Description: First opened up in 1888. This mine ships a Non-Bessemer Hematite, which is not crushed. The mine is worked by the caving system. The greatest vertical depth is 590 feet. The ore is shipped via the L. S. & I. and the C. & N. W. Railways to Presque Isle and Escanaba, and thence by boat to lower lake ports.

Operating Company: Cleveland Cliffs Iron Co., Ishpeming, Mich.

Manager: M. M. Duncan.

Manager: M. M. Duncan. **Superintendent:** L. Eaton.

Sales Agents: Cleveland Cliffs Iron Co., Cleveland, Ohio.

Yearly Shipments:

1892—188,439 tons	1898—386,088 tons
1893—162,700 tons	1899—464,549 tons
1894— 94,715 tons	1900—457,453 tons
1895—160,790 tons	1901—406,783 tons
1896—162,326 tons	1902—448,427 tons
1897—339,521 tons	1903—456,514 tons

 1904—399,621 tons
 1909—463,478 tons

 1905—568,568 tons
 1910—244,923 tons

 1906—600,002 tons
 1911—166,850 tons

 1907—552,530 tons
 1912—495,651 tons

 1908—250,252 tons
 1913—517,059 tons

 Total, Tons
 7,987,257

Analysis: The average of all cargo analyses for 1913 is as fol-

lows: Dried at 212° F.

 Iron
 Phos. Silica
 Mang. 79
 Alum. Lime Magnes. Sulph. Loss 4.26
 Loss 58.50
 .123
 5.74
 .79
 2.76
 .49
 .93
 .012
 4.26

The ore in its natural state is as follows:

Moist Iron Phos. Silica 13.00 50.90 .107 4.99

HIMROD MINE.

Location: Marquette County, Michigan, Section 7, Township 47 North, Range 26 West.

Description: First opened up in 1873. The ore is hard, red, siliceous Hematite. It is worked as an open-pit mine.

The ore is shipped via the D. S. S. & A. Railway to Marquette, Mich., and from there to the lower lake ports by boat.

Sales Agents: E. N. Breitung & Co., Cleveland, Ohio.

Analysis: The expected analysis for 1914 is as follows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 41.75 .054 36.20 .03 1.28 .38 .05 .05 .005 1.50

The ore in its natural state is as follows:

Moist Iron Phos. Silica 4.00 40.08 .052 34.75

IMPERIAL MINE.

Location: Baraga County, Michigan, Section 25, Township 48, Range 31.

Description: The mine was first opened up in 1882. The ore is a soft, yellow, Non-Bessemer Limonite, and is not crushed. The mine is worked by the caving system, the greatest vertical depth being 205 feet. The ore is shipped via the D. S. S. & A. Railway to Marquette and thence by boat to lower lake ports.

Operating Company: The Cleveland Cliffs Iron Co., Ishpeming, Mich.

Manager: M. M. Duncan. Superintendent: L. Eaton.

Sales Agents: Cleveland Cliffs Iron Co., Cleveland, Ohio.

Yearly Shipments:

```
1890--- 38,460 tons
                                     1902-
1891— 18,552 tons
                                     1903-
                                     1904---
1892- 7,194 tons
                                               727 tons
1893---
                                     1905— 1,661 tons
                                     1906— 5,076 tons
1894---
                                     1908-- 55,756 tons
1895---
                                     1909— 48,231 tons
1896-
                                     1910-115,478 tons
1897-
                                     1911-84,843 tons
1898--
1899- 23,235 tons
                                     1912— 54.053 tons
1900- 62,321 tons
                                     1913- 37,542 tons
1901—
```

Total, Tons.......636,533

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 52.00 .330 10.00 .28 .03 3.28 2.31 .058 8.35

The ore in its natural state is as follows:

Moist Iron Phos. Silica 10.60 46.49 .295 8.94

LAKE SUPERIOR (HARD) MINE.

Location: Marquette County, Michigan, Sections 9 and 10, Township 47, Range 27.

Description: First opened up in 1857. This mine ships five grades of ore: ABBOTSFORD, a hard, blue, Bessemer Hematite; BERESFORD, a hard, steel-blue, Non-Bessemer Hematite; CASTLEFORD, a hard dark-gray, Non-Bessemer, Silicious Hematite; CASTLEGUARD, a hard, steel-blue, Bessemer, Silicious Hematite; and BEDFORD, a soft, dark-red, Non-Bessemer Hematite. None of this ore is crushed. The mine is worked by underground methods, the greatest vertical depth being 1,228 feet. The ore is shipped via the D. S. S. & A. and the L. S. & I. Railways to Marquette and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Ishpeming, Mich. General Manager: J. H. McLean.

General Superintendent: W. H. Johnston.

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Yearly Shipments:
           Lake Superior
                                                         1885-
                                                                -226,040 tons
            1857-
                                                         1886-
                                                                -267,622 tons
-302,909 tons
            1858-
                      4,658 tons
                                                         1887-
                  – 24,668 tons
            1859-
                                                         1888
                                                                 240,225 tons
            1860-
                  - 33,015 tons
                                                         1889
                                                                 -288,784 tons
            1861— 25,195 tons
1862— 37,709 tons
                                                         1890
                                                                 318,321 tons
                                                                 308,831 tons
                                                         1891
            1863— 78,976 tons
                                                         1892
                                                                 366.715 tons
                 - 86,773 tons
- 55,201 tons
            1864
                                                         1893
                                                                 329,610 tons
                                                                -344,758 tons
-342,439 tons
            1865-
                                                         1894
            1866-- 68,002 tons
                                                         1895
                                                                 459.576 tons
            1867—119,935 tons
                                                         1896
           1868—105,745 tons
1869—135,560 tons
                                                         1897
                                                                 376,761 tons
                                                                -686,563 tons
-682,595 tons
                                                         1898
            1870-166,582 tons
                                                         1899
            1871—158,047 tons
                                                         1900-
                                                                -709,143 tons
           1872—195,617 tons
1873—158,428 tons
1874—124,311 tons
                                                         1901-
                                                                -635,642 tons
                                                         1902-
                                                                -832,796 tons
                                                         1903
                                                                -604,829 tons
            1875—129,365 tons
                                                         1904
                                                                -590,339 tons
           1876—110,570 tons
1877—127,349 tons
1878—109,674 tons
                                                                -727,378 tons
-635,671 tons
                                                         1905
                                                         1906-
                                                         1907
                                                                -674,066 tons
           1879—174,747 tons
                                                         1908-
                                                                -261,955 tons
           1880—204,094 tons
1881—262,235 tons
1882—296,509 tons
1883—200,799 tons
                                                         1909—349,435 tons
1910—271,445 tons
                                                         1911-174,959 tons
                                                         1912—219,673 tons
1913—203,964 tons
           1884
                  -204,796 tons
                          Total, Tons......15,831,604
Analysis:
               The average of all cargo analyses for 1913 is as fol-
               Dried at 212° F.
    lows:
  Abbotsford:
               Phos.
                        Silica
                                   Mang.
                                            Alum.
                                                       Lime Magnes. Sulph.
     Iron
     61.84
                .034
                         8.29
                                    .12
  Beresford:
     Iron
               Phos.
                        Silica
                                   Mang.
                                            Alum.
                                                       Lime Magnes. Sulph.
                                                                                     Loss
    62.83
                .090
                         5.90
                                     .07
  Bedford:
                        Silica
     Iron
               Phos.
                                   Mang.
                                            Alum.
                                                       Lime Magnes. Sulph.
     55.35
                .083
                        14.27
                                    .40
  Castleguard:
               Phos.
                        Silica
     Iron
                                   Mang.
                                            Alum.
                                                       Lime Magnes. Sulph.
                                                                                     Loss
     52.87
                .048
                        20.41
                                    .15
  Castleford:
               Phos.
                        Silica
                                   Mang.
                                            Alum.
                                                       Lime Magnes. Sulph.
     Iron
                                                                                     Loss
    53.81
               .091
                        17.59
                                    .17
    The ore in its natural state is as follows:
  Abbotsford:
    Moist
                     Phos.
                               Silica
             Iron
              59.85
     3.22
                       .033
                                8.02
  Beresford:
                               Silica
     Moist
             Iron
                      Phos.
     1.25
             62.04
                       .089
                                5.83
```

Bedford:

Moist Iron Phos. Silica 11.22 49.13 .089 12.66

Castleguard:

Moist Iron Phos. Silica 3.15 51.20 .047 19.77

Castleford:

Moist Iron Phos. Silica 1.97 52.75 .089 17.24

LAKE SUPERIOR (SQFT) MINE.

Location: Marquette County, Michigan, Sections 10 and 21, Township 47, Range 27.

Description: First opened up in 1857. The mine ships two grades of ore: BEDFORD, a soft, dark-red Non-Bessemer Hematite; and CASTLEGUARD, a hard, blue Bessemer Silicious Hematite. This ore is not crushed. The mine is worked by underground methods, the greatest vertical depth being 824 feet. The ore is shipped via the D. S. S. & A. and the L. S. & I. Railways to Marquette, and thence by boat to lower lake ports.

Operating Company: The Oliver Iron Mining Co., Ishpeming, Mich.

General Manager: J. H. McLean.

General Superintendent: W. H. Johnston.

Analysis: See analysis of BEDFORD and CASTLEGUARD.

LILLIE MINE.

Location: Marquette County, Michigan, Section 35, Township 48, Range 27.

Description: First opened up in 1875. The ore is a hard, brown, Non-Bessemer Hematite.

The mine is worked by stoping system. Greatest vertical depth 1,000 feet.

The ore is shipped via the C. & N. W. and D. S. S. & A. Railways to Escanaba and Marquette and from there to the lower lake ports by boat.

The mine is operated by the Republic Iron & Steel Co., Youngstown, Ohio.

Sales Agents: M. A. Hanna & Co., Cleveland, Ohio.

Yearly Shipments:

```
1895— 54,285 tons
1896—107,532 tons
           144 tons
1875-
1876— 5,801 tons
1877— 10,127 tons
                                              1897-112,781 tons
         8,506 tons
1878-
                                              1898-
                                                    -211,023 tons
        22,380 tons
18,347 tons
16,748 tons
                                              1899—196,200 tons
1879
                                              1900-114,990 tous
1880-
                                                    - 98,788 tons
                                              1901-
1881-
                                              1902-
1882-
       - 27,494 tons
                                                     - 79,919 tons
                                                    - 77,454 tons
- 63,209 tons
1883
          4,614 tons
                                              1903-
                                              1904
1884
          2,683 tons
           708 tons.
                                                      9,868 tons
1885
                                              1905-
          3,957 tons
1886
                                              1906-
                                                     - 32,781 tons
                                                    - 80,545 tons
                                              1907-
1887
        23,041 tons
                                              1908-
1888-
        32,692 tons
                                                       8,632 tons
        33,916 tons
                                              1909-
                                                    - 61,708 tons
1889
                                              1910— 10,121 tons
1890-
        31,812 tons
      – 19.551 tons
                                             1911— 844 tons
1912—109,584 tons
1891-
      - 29,005 tons
1892-
1893-68,861 tons
                                              1913-
1894— 78,388 tons
               Total, Tons..........1,869,039
```

LLOYD MINE.

Location: Marquette County, Michigan, Section 6, Township 47, Range 27.

Description: First opened up in 1909. Three grades of ore are shipped from this mine: NORTH LAKE BESSEMER, a Bessemer Hematite; NORTH LAKE, a Non-Bessemer Hematite; and NORTH LAKE SILICIA, a silicious Hematite. The ore is not crushed. The mine is worked by the caving and shrinkage stope systems, the greatest vertical depth being 830 feet. The ore is shipped via the L. S. & I. Railway to Presque Isle, and thence by boat to lower lake ports.

Operating Company: The Cleveland Cliffs Iron Co., Ishpeming, Mich.

Manager: M. M. Duncan.

Superintendent: W. W. Graff.
Sales Agents: The Cleveland Cliffs Iron Co., Cleveland, Ohio.

Yearly Shipments:

1911- 28,003 tons 1913—135,746 tons 1912— 44,467 tons Total, Tons........208,216

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

North Lake:

Iron 58.50	Phos067	Silica 6.97	Mang. .37	Alum. 2.01	Lime .70	Magnes.	Loss 5.82
North La							 _
Iron 51.30		Silica 16.88				Magnes. .34	Loss 5.52

The ore in its natural state is as follows:

North Lake:

Moist Iron Phos. Silica
9.75 52.80 .060 6.29

North Lake Silica:

Moist Iron Phos. Silica
9.75 46.30 .047 15.23

LUCY MINE.

Location: Marquette County, Michigan, Sections 6 and 7, Township 47, Range 26.

Description: First opened up in 1878. The ore is a silicious and manganiferous, soft Hematite, and is not crushed. The mine is worked by the caving system, the greatest vertical depth being 390 feet. The ore is shipped via the L. S. & I. and the C. & N. W. Railways to Presque Isle and Escanaba, and thence by boat to the lower lake ports.

Operating Company: Cleveland Cliffs Iron Co., Ishpeming, Mich.

Manager: M. M. Duncan. Superintendent: S. R. Elliot.

Sales Agents: Cleveland Cliffs Iron Co., Cleveland, Ohio.

Yearly Shipments:

1896—
1897— 10,033 tons
1898— 11,846 tons
1899—
1900
1901
1902—
1903
1904
1905—
1906 85 tons
1907
1908— 1.115 tons
1909— 1,672 tons
1909— 1,672 tons 1910— 11,257 tons 1911— 16,677 tons
1911— 16,677 tons
1912— 73,120 tons
1913— 2,025 tons
Tons622,110

MAAS MINE.

Location: Marquette County, Michigan, Section 31, Township

48, Range 26.

Description: First opened up in 1902. This mine ships two grades of ore: MAAS BESSEMER, a soft, Bessemer Hematite; and MAAS, a soft, Non-Bessemer Hematite. The ore

is not crushed. The mine is worked by the caving system, the greatest vertical depth being 1,100 feet. The ore is shipped via the L. S. & I. Railway to Presque Isle and thence by boat to lower lake ports.

Operating Company: The Cleveland Cliffs Iron Co., Ishpeming, Mich.

Manager: M. M. Duncan. Superintendent: S. R. Elliot.

Sales Agents: The Cleveland Cliffs Iron Co., Cleveland, Ohio.

Yearly Shipments:

 1907— 32,378 tons
 1911— 24,927 tons

 1908— 29,036 tons
 1912— 46,249 tons

 1909—159,197 tons
 1913—170,705 tons

 1910—208,103 tons

Total, Tons.......670,595

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Maas:

 Iron
 Phos. 5ilica
 Mang. 2.30
 Alum. Lime 1.53
 Magnes. Sulph. 2.3
 Loss 3.46

The ore in its natural state is as follows:

Moist Iron Phos. Silica 11.60 52.07 .088 6.28

MARY CHARLOTTE NO. 1 MINE.

Location: Marquette County, Michigan, N. E. 1/4, S. W. 1/4, Section 8, Township 47 North, Range 26 West.

Description: First opened up in 1903. Two ores are shipped from this mine, MARY and CHARLOTTE, soft, red, Non-Bessemer Hematites.

It is worked by the caving system. Greatest vertical depth 365 feet.

The ore is shipped via the D. S. S. & A. and C. & N. W. Railways to Marquette and Escanaba, and from there to the lower lake ports by boat.

Operating Company: The Mary Charlotte Mining Co. Manager: E. N. Breitung, 11 Pine St., New York, N. Y.

Superintendent: W. B. Pattison, Negaunee, Mich. Sales Agents: E. N. Breitung & Co., Cleveland, Ohio.

Yearly Shipments:

Analysis: The average of all cargo analyses for 1913 is as fol-Dried at 212° F. lows:

Mary:

Mang. Alum. Lime Magnes. Sulph. Phos. Silica Loss Iron 58.39 .22 2.86 .82 .92 .108 2.09 .096 8.96

Charlotte: Phos. Silica Mang. Iron 54.27

Alum. Lime Magnes. Sulph. Loss 2.00 14.91 2.62 .82 .88 .132 .085 .26 The ore in its natural state is as follows:

Moist Iron Phos. 50.06 .082 14.27

Charlotte: Moist Iron Phos. Silica 13.08 47.18 .073 12.96

MARY CHARLOTTE NO. 2.

Location: Marquette County, Michigan, N. W. 1/4, S. W. 1/4 of Section 8, Township 47 North, Range 26 West.

Description: First opened up in 1908. Two ores are shipped from this mine, MARY and CHARLOTTE, soft, red, Non-Bessemer Hematites.

The mine is worked by the caving system. Greatest vertical

depth 470 feet.

The ore is shipped via the D. S. S. & A. and C. & N. W. Railways to Marquette and Escanaba, and from there by boat to the lower lake ports.

Operating Company: The Mary Charlotte Mining Co. Manager: E. N. Breitung, 11 Pine St., New York, N. Y. Superintendent: W. B. Pattison, Negaunee, Mich.

Sales Agents: E. N. Breitung & Co., Cleveland, Ohio.

MILWAUKEE-DAVIS MINE.

Location: Marquette County, Michigan, Section 7, Township 47 North, Range 26 West.

Description: First opened up in 1879. Two ores are shipped from this mine, MILWAUKEE and DAVIS, both soft, red, Non-Bessemer Hematites.

Greatest vertical depth is 373 feet.

The ore is shipped via the D. S. S. & A. Railway to Marquette, and from there by boat to the lower lake ports. The mine was shut down in 1890, but is now being opened up and developed.

Operating Company: Breitung Hematite Mining Co. Manager: E. N. Breitung, 11 Pine St., New York, N. Y. Superintendent: W. B. Pattison, Negaunee, Mich.

Sales Agents: E. N. Breitung & Co., Cleveland, Ohio.

```
Yearly Shipments:
                                               1885- 38,465 tons
         Milwaukee
          1879---
                   941 tons
                                               1886
                                                       46,693 tons
          1880— 13,142 tons
                                                     - 50,470 tons
                                               1887-
          1881— 31,635 tons
                                               1888-
                                                     – 48,908 tons
         1882— 40,891 tons
1883— 805 tons
                                               1889— 52,727 tons
                                               1890-24,763 tons
              - 25,991 tons
          1884
                       Total, Tons......375,431
                                               1892— 22,823 tons
1893— 352 tons
         Davis (formerly Grand
                                               1894--- 12,073 tons
            Rapids)
         1887— 1,200 tons
1888— 11,611 tons
                                               1895
                                                       6,764 tons
                                               1896-
                                                          67 tons
         1889— 20,058 tons
                                                       7,781 tons
                                               1911-
         1890-- 26,426 tons
                                               1912-11,537 tons
                                                     - 10,412 tons
         1891— 9,362 tons
                                               1913-
                       Total, Tons......515,898
Analysis: The average of all cargo analyses for 1913 is as fol-
            Dried at 212° F.
    lows:
  Milwaukee:
                             Mang.
    Iron
            Phos.
                    Silica
                                     Alum.
                                             Lime Magnes. Sulph.
                                                                      Loss
    57.65
                                                                       2.70
                                             1.70
             .137
                     8.92
                              .32
                                     1.51
                                                       1.82
                                                               .014
  Davis:
                            Mang. Alum.
            Phos. Silica
                                             Lime Magnes. Sulph.
                                                                      Loss
    Iron
            .127
                    5.25
                             .45
                                     1.19
                                             1.10
                                                       .72
                                                               .02
                                                                       2.08
    The ore in its natural state is as follows:
  Milwaukee:
    Moist Iron Phos.
                         Silica
    12.50
           50.44
                   .119
  Davis:
    Moist Iron Phos.
                         Silica
    10.00
           55.26
                   .114
```

MORO MINE.

Location: Marquette County, Michigan, Section 10, Township 47, Range 27.

Description: First opened up in 1881, and closed in 1912. The ore, SCOTCH SILICA, is a hard, Non-Bessemer, specular Hematite, and was crushed. The mine was worked by the room and pillar systems, the greatest vertical depth being 825 feet. The ore was shipped via the L. S. & I. Railway to Presque Isle, and thence by boat to lower lake ports.

Operating Company: Cleveland Cliffs Iron Co., Ishpeming, Mich.

Manager: M. M. Duncan. Superintendent: L. Eaton.

Sales Agents: Cleveland Cliffs Iron Co., Cleveland, Ohio.

Yearly Shipments:	•
1892— 42,916 tons	1903— 72,441 tons
1893— 25,824 tons	1904— 1,993 tons
1894— 23,012 tons	1905—121,295 tons
1895— 12,737 tons	1906—106,154 tons
1896— 28,003 tons	1907— 77,292 tons
1897— 12,678 tons	1908— 661 tons
1898—	1909— 47,074 tons
1899— 5,459 tons	1910—125,430 tons
1900— 72,124 tons	1911—
1901—	1912— 7,862 tons
1902— 68,811 tons	1913— 75,512 tons
Total,	Tons927,278

MORRIS MINE.

Location: Marquette County, Michigan, Section 1, Township

47, Range 28.

Description: First opened up in 1909. This mine ships three grades of ore: MORRIS BESSEMER, a Bessemer Hematite; MORRIS, a Non-Bessemer Hematite; and MORRIS SILICA, a silicious Hematite. The ore is not crushed. The mine is worked by the caving and shrinkage stope systems, the greatest vertical depth being 815 feet. The ore is shipped via the L. S. & I. to Presque Isle, and thence by boat to lower lake ports.

Operating Company: The Cleveland Cliffs Iron Co., Ishpeming,

Mich.

Manager: M. M. Duncan.

Superintendent: W. W. Graff.
Sales Agents: The Cleveland Cliffs Iron Co., Cleveland, Ohio.

Yearly Shipments:

1912— 1,286 tons 1913-18,394 tons 'otal, Tons......19,680

NEGAUNEE MINE.

Marquette County, Michigan, Sections 5 and 6, Location:

Township 47, Range 26.

Description: First opened up in 1887. The mine ships two ores: NEGAUNEE, a soft, Non-Bessemer Hematite; and NEGAUNEE BESSEMER, a soft, Bessemer Hematite. The ore is not crushed. The mine is worked by the caving system, the greatest vertical depth being 885 feet. The ore is shipped via the L. S. & I. and the C. & N. W. Railroads to Presque Isle and Escanaba, and thence by boat to lower lake ports.

Operating Company: Negaunee Iron Co., Ishpeming, Mich. Manager: M. M. Duncan.

Superintendent: S. R. Elliot.

Sales Agents: Cleveland Cliffs Iron Co., Cleveland, Ohio.

```
Yearly Shipments:
                  5.259 tons
          1887---
                                                  1901—234,713 tons
          1888— 45,304 tons
1889— 78,318 tons
                                                        -204,286 tons
                                                  1902-
                                                  1903-
                                                        -224,665 tons
               - 76,488 tons
          1890-
                                                  1904-145,132 tons
          1891-
                - 64,218 tons
                                                  1905-
                                                        -239,554 tons
                                                        -253,488 tons
-296,170 tons
          1892-
                - 85,846 tons
                                                  1906-
                                                  1907-
          1893-
               - 69,732 tons
          1894—132,581 tons
                                                  1908-
                                                        -232,219 tons
          1895— 90,682 tons
1896—175,394 tons
1897—182,169 tons
                                                  1909-
                                                        -312,217 tons
                                                  1910-348,818 tons
                                                  1911—140,406 tons
          1898—191,330 tons
                                                  1912-446,318 tons
          1899—195,573 tons
                                                  1913—326,877 tons
          1900-126,829 tons
                       Total, Tons......4,924,546
            The average of all cargo analyses for 1913 is as fol-
Analysis:
    lows: Dried at 212° F.
  Negaunee:
             Phos.
                     Silica
                              Mang.
                                       Alum.
                                                Lime Magnes. Sulph.
                                                                          Loss
    Iron
    58.92
              .090
                      7.65
                                .21
                                        2.82
                                                1.17
                                                           .32
                                                                           2.73
  Negaunce Bessemer:
                              Mang.
    Iron
             Phos.
                     Silica
                                       Alum.
                                                Lime Magnes. Sulph.
                                                                          Loss
                                       2.57
    60.23
              .060
                      6.97
                               .21
                                                 .89
                                                           .27
                                                                           2.09
    The ore in its natural state is as follows:
  Negaunee:
                   Phos.
    Moist Iron
                           Silica
    11.58
            51.94
                    .079
                            6.74
  Negaunce Bessemer:
    Moist Iron
                   Phos.
                           Silica
    12.40
            52.76
                    .053
                            6.11
```

NORTH JACKSON MINE.

Location: Marquette County, Michigan, Section 1, Township 47, Range 27.

Description: The original JACKSON MINE was first opened up in 1848. The mine is now divided and known as NORTH and SOUTH JACKSON, although they are both operated by the same company. The ore from NORTH JACKSON is a red, hard-silicious, hard Hematite, and is crushed. The mine is worked by the open-pit method, the greatest vertical depth being 100 feet. The ore is shipped via the L. S. & I. and the C. & N. W. Railroads to Presque Isle and Escanaba, and thence by boat to lower lake ports.

Operating Company: The Jackson Iron Co., Ishpeming, Mich. Manager: M. M. Duncan.

Superintendent: S. R. Elliot.

Sales Agents: The Cleveland Cliffs Iron Co., Cleveland, Ohio.

Yearly Shipments: North and South Jackson Mines. Prior to 1857—28,463 tons 1857— 12,442 tons 1858— 10,309 tons 1885— 68,657 tons 1886— 89,370 tons 1886— 89,370 tons 1887—109,606 tons 1859— 28,377 tons 1888—101,909 tons 1889—128,891 tons 1890—124,682 tons 1860— 41,295 tons 1861— 12,919 tons - 46,096 tons - 92,979 tons 1862-1891-- 77,237 tons - 83,905 tons - 92,567 tons 1863-1892-- 51,009 tons 1864 1893-- 65,505 tons 1865-1894 - 32,298 tons 1866-- 92,287 tons 1895 - 42,186 tons 1867—127,491 tons 1896 - 80,710 tons 1868—130,524 tons 1869—125,908 tons - 79,102 tons 1897-1898-- 55,012 tons 1870—127,642 tons 1871—138,297 tons 1872—119,910 tons 1873—130,131 tons 1899-- 88,230 tons 1900-- 31,714 tons - 38,271 tons - 15,449 tons 1901-1902-1874--- 94,708 tons 1903 5,409 tons 1875— 87,283 tons 1876— 98,480 tons 1877— 80,340 tons 1904 1905-- 33,180 tons 1906-5,066 tons 1878— 83,121 tons 1907 - 61,345 tons 1879—112,921 tons 1908 1880—120,622 tons 1881—118,939 tons 1909— 11,060 tons 1910— 40,320 tons 1882— 96,830 tons 1883— 71,278 tons 1884— 83,251 tons 1911-- 52,615 tons 1912-- 50,166 tons 1913-

OGDEN MINE.

Total, Tons.....4,029,833

1,519 tons

Location: Marquette County, Michigan, Section 13, Township 47, Range 27.

Description: Opened up about forty years ago. The ore is called TILDEN SILICA, a hard, silicious Hematite.

It is a quarry on a sidehill, all above the Railway.

The ore is shipped via the C. & N. W. Railway to Escanaba and from there by boat to the lower lake ports.

Sales Agents: Cleveland Cliffs Iron Co., Cleveland.

Yearly Shipments:

Prior to 1898-986	tons	1900	15,325	tons
1898— 50,833 tons		1901—		
1899— 27,345 tons		1902—	4,621	tons
Total.	Tons10	9.752		

OHIO MINE (Formerly Beaufort Mine).

Baraga County, Michigan, Section 22, Township 48, Location: Range 31 West.

Description: First opened up in 1881. The ore is both a hard and soft, red-yellow, Non-Bessemer Limonite, and is not crushed. The mine is worked by the room and pillar system,

the greatest vertical depth being 265 feet. The ore is shipped via the D. S. S. & A. Railway to Marquette and Escanaba and thence by boat to lower lake ports.

Operating Company: The Niagara Iron Mining Co., Ishpeming, Mich.

Manager: G. L. Woodworth. Superintendent: A. Carlson.

Sales Agents: Tonawanda Iron & Steel Co., Buffalo, N. Y., and Oglebay, Norton & Co., Cleveland, Ohio.

Yearly Shipments:

1882— 5,532 tons	1904— 25,781 tons
1883— 18,976 tons	1905— 38,306 tons
1884— 18,360 tons	1906—
1885— 17,166 tons	1907— 78,029 tons
1886— 17,354 tons	1908— 61,035 tons
1887— 12,829 tons	1909— 72,987 tons
1888-1899	1910— 23,427 tons
1900— 1,583 tons	1911— 2,684 tons
1901— 4,338 tons	1912—
1902— 59,781 tons	1913
1903—134,648 tons	
Total,	Tons592,816

PORTLAND MINE.

Location: Baraga County, Michigan, N. 1/2 N. W. 1/4, Section 26, Township 48 North, Range 31 West.

Description: First opened up in 1909. Ore soft, red and yellow, Non-Bessemer Hematite and Limonite. The open-pit, steam shovel system of mining is used. The greatest vertical depth is about 50 feet. The ore is shipped via the Duluth, South Shore & Atlantic Railway to Marquette, Michigan; and via the Chicago & Northwestern Railway to Escanaba, and from there to the lower lake ports by boat.

Operating Company: Niagara Iron Mining Co., mine office, Michigamme, Mich.; general office, Iron River, Mich.

Manager: G. L. Woodworth.

Superintendent: Alfred Carlson.

Sales Agents: Tonawanda Iron & Steel Co., Buffalo, N. Y., and Oglebay, Norton & Co., Cleveland, Ohio.

Yearly Shipments:

1909— 79,653 1910— 49,584 1911—			1912— 1913—
1911—	Total,	Tons	. 129,236

PRINCETON MINE.

Location: Marquette County, Michigan, Sections 18 and 20, Township 45, Range 25.

Description: First opened up in 1872. There are two ores shipped from this mine, PRINCETON and CAMBRIDGE, soft, Non-Bessemer Hematites.

Mine is worked by the caving system. Greatest vertical

depth 383 feet.

The ore is shipped via the C. & N. W. and Munising Railways to Escanaba and Presque Isle and from there by boat to the lower lake ports.

Sales Agents: Cleveland Cliffs Iron Co., Cleveland, Ohio.

Yearly Shipments:

man-p-monto i	
Swanzey and Cheshi	re Princeton
Combined	1891— 7,301 tons
1872— 13,415 tons	1892— 29,403 tons
1873— 9,329 tons	1893— 19,096 tons
1874—	1894—
1875— 188 tons	1895— 6,593 tons
1876— 225 tons	1896—
1877— 8,423 tons	1897—
1878— 16,924 tons	1898— 25,247 tons
1879— 17,985 tons	1899— 55,802 tons
1880— 13,202 tons	1900— 75,037 tons
1881— 5,674 tons	1901— 67,051 tons
	1902—118,048 tons
Swanzey	1903— 84,223 tons
1881— 9,337 tons	1904— 76,461 tons
1882— 31,498 tons	1905—129,079 tons
1883— 13,730 tons	1906—166,894 tons
1884— 3,557 tons	-1907—177,863 tons
1885—	1908— 36,033 tons
1886— 8,328 tons	1909— 42,934 tons
1887— 2,842 tons	1910— 89,441 tons
1888—	1911— 27,962 tons
1889	1912—162,138 tons
1890	1913— 53,476 tons
Total.	Tons1,604,778

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Cambridge:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 60.05 .701 4.07 .89 .86 2.47 1.00 .019 1.66 Princeton:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 61.00 .197 5.60 .75 1.49 2.00 1.00 .020 1.85 The ore in its natural state is as follows:

Cambridge:

Moist Iron Phos. Silica 15.00 51.04 .596 3.46

Princeton:

Moist Iron Phos. Silica 13.50 52.77 .170 4.84

QUEEN MINE.

Location: Marquette County, Michigan, Section 5, Township 47, Range 26.

Description: First opened up in 1888. Two ores are shipped from this mine, BUFFALO and CAMEO, hard, and soft, dark red, Non-Bessemer Hematites.

It is an underground mine. Greatest vertical depth 1,046 feet. The ore is shipped via the C. & N. W. and D. S. S. & A. Railways to Marquette and Escanaba and from there by boat to the lower lake ports.

Operating Company: Oliver Iron Mining Co., Negaunee, Mich. General Manager: J. H. McLean.

General Superintendent: W. H. Johnston.

Yearly Shipments:

```
1888— 5,527 tons
1889— 66,122 tons
                                               1901—400,845 tons
1902—418,044 tons
1890-141,632 tons
                                               1903-
                                                      -254,658 tons
                                                      -311,479 tons
-253,377 tons
1891—479,509 tons
1892—379,719 tons
                                               1904
                                               1905-
1893-106,864 tons
                                                      -221,096 tons
                                               1906-
1894-
      -220,298 tons
                                               1907-
                                                     -309.917 tons
1895—160,817 tons
                                               1908-
                                                      –104,098 tons
1896—323,057 tons
1897—239,774 tons
1896-
                                               1909-237,509 tons
                                               1910-230,119 tons
1898— 61,022 tons
                                               1911-297,675 tons
1899-342,978 tons
                                               1912—351,916 tons
1913—298,504 tons
1900-398,298 tons
               Total, Tons......7,170,635
```

The average of all cargo analyses for 1913 is as fol-Analysis: Dried at 212° F. lows:

Buffalo-Cameo:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 52.53 .106 6.42 .63 The ore in its natural state is as follows:

Moist Iron Phos. Silica 13.78 50.46 .091

REPUBLIC MINE.

Location: Marquette County, Michigan, Section 7, Township 46 North, Range 29 West.

Description: First opened up in 1871. Ore is principally specular, a small part being magnetite. Three ores are shipped from this mine: BESSEMER CRUSHED, a hard, blue, Bessemer; BASIC CRUSHED, a hard, blue, Non-Bessemer; BASIC LUMP, a hard, blue, Non-Bessemer.

The shrinkage stoping method of mining is now used. Greatest vertical depth is 2,050 feet.

The ore is shipped via the C. M. & St. Paul, D. S. S. & A. and

the C. & N. W. Railways to Escanaba and Marquette and from there by boat to the lower lake ports.

Operating Company: Cleveland Cliffs Iron Co., Republic, Mich.

Manager: M. M. Duncan.

Superintendent: W. A. Siebenthal.

Sales Agents: Cleveland Cliffs Iron Co., Cleveland, Ohio.

Yearly Shipments:

	•
1872— 11,025 tons	1893— 64,195 tons
1873—105,453 tons	1894—105,719 tons
1874—122,639 tons	1895—174,027 tons
1875—119,726 tons	1896—127,360 tons
1876—120,095 tons	1897—124,342 tons
1877—165,836 tons	1898—140,312 tons
1878—176,221 tons	1899—137,085 tons
1879—135,231 tons	1900—130,126 tons
1880—235,387 tons	1901—104,604 tons
1881—233,786 tons	1902—157,646 tons
1882—235,109 tons	1903—155,415 tons
1883—152,565 tons	1904—124,506 tons
1884—277,757 tons	1905—150,699 tons
1885—250,835 tons	1906—177,220 tons
1886—241,161 tons	1907—170,554 tons
1887—220,624 tons	1908— 67,999 tons
1888—235,062 tons	1909—176,575 tons
1889—287,390 tons	1910—150,732 tons
1890—220,065 tons	1911—113,012 tons
1891—191,127 tons	1912—156,864 tons
1892—167,991 tons	1913—137,063 tons
Total,	Tons6,751,142

Analysis: The average of all cargo analyses for 1913 is as fol-Dried at 212° F. lows:

Bessemer Crushed:

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 64.30 .040 5.97 .04 1.14 .47 .28 .36 .008 Basic:

Iron

Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 60.20 2.15 .054 10.43 .06 .012 .48 .54 .41

Basic Lump:

Phos. Silica Mang. Alum. Lime Magnes. Sulph. Iron Loss 63.80 .061 6.35 None 1.71 .33 .19 .029 None The ore in its natural state is as follows:

Bessemer Crushed:

Moist Iron Phos. Silica 1.16 63.55 .040 5.90

Basic:

Moist Iron 1.30 59.42 Phos. Silica .053 10.29

Basic Lump:

Moist Iron Phos. Silica .40 63.54 .061 6.32

RICHMOND MINE.

Location: Marquette County, Michigan, Section 28, Township 47, Range 26.

Description: First opened up in 1896. Ore is hard, red, silicious Hematite, and is crushed. The open-pit system of mining is now used. The ore is shipped via the C. & N. W. Railway to Escanaba and from there to the lower lake ports by boat.

Operating Company: Richmond Iron Company, Palmer, Mich.

Manager: James D. Ireland. Superintendent: John Huhtala.

Sales Agents: M. A. Hanna & Company, Cleveland, Ohio.

Yearly Shipments:

•	
1896— 1,088 tons	1905— 86,129 tons
1897— 4,630 tons	1906— 89,563 tons
1898— 24,464 tons	1907— 35,156 tons
1899— 4,613 tons	1908— 60,994 tons
1900 51,303 tons	
1901— 54,181 tons	1910— 95,772 tons
1902— 50,041 tons	
1903— 55,593 tons	
1904— 68,134 tons	1913—138,394 tons
Total	Tons 1 088 761

Analysis: The average of all cargo analyses for 1913 is as fol-

lows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 40.30 .043 37.90 .13 .90 .18 .20 .021 2.26

The ore in its natural state is as follows:

Moist Iron Phos. Silica 2.84 39.16 .042 36.82

ROLLING MILL MINE.

Location: Marquette County, Michigan, City of Negaunee, Section 13, Township 47, Range 27.

Description: First opened up in 1872. Ore is a soft, red, Non-Bessemer Hematite.

Mine is worked by the underground slicing system. Greatest vertical depth 698 feet.

The ore is shipped via the L. S. & I., D. S. S. & A., and C. & N. W. Railways to L. S. & I. docks, Marquette, and from there by boat to the lower lake ports.

The mine is operated by Jones & Laughlin Ore Co.

Yearly Shipments:

```
- 6,772 tons
- 11,319 tons
1872-
                                                1897-
                                                          3,975 tons
                                                 1898-
1874
       - 16.643 tons
                                                1899
                                                       - 22,585 tons
- 22,815 tons
      - 37,806 tons
- 53,265 tons
                                                1900-
1875-
                                                1901-
1876-
                                                       - 24,874 tons
                                                1902-
      - 38,121 tons
1877-
1878-
       - 30,773 tons
                                                1903
                                                          6,786 tons
1879-
                                                1904
      - 10,039 tons
      - 15,172 tons
- 1,668 tons
1880-
                                                1905-
                                                       - 28,766 tons
                                                1906
1881-
1882
            163 tons
                                                1907
                                                         49,204 tons
          1,528 tons
                                                1908
                                                        - 52,147 tons
1883
          1,820 tons
3,437 tons
                                                1909-133,139 tons
1884
1885
                                                1910-115,193 tons
                                                1911— 96,585 tons
1912—115,784 tons
1913—163,286 tons
1886
          4.403 tons
1887-
          1,058 tons
1888
            402 tons
               Total, Tons......1,069,764
```

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 59.10 .104 6.45

The ore in its natural state is as follows:

Moist Iron Phos. Silica 13.85 50.91 .089 5.56

SALISBURY MINE.

Location: Marquette County, Michigan, Section 15, Township 47, Range 27.

Description: First opened up in 1872. Four ores are shipped from this mine: SALISBURY BESSEMER, a Bessemer Hematite; SALISBURY, a soft, Non-Bessemer Hematite; CLINTON, a soft, Non-Bessemer Hematite; CLINTON SILICA, a soft, silicious Hematite. The ore is not crushed. The mine is worked by the caving system. The greatest vertical depth is 942 feet. The ore is shipped via the L. S. & I., C. & N. W. and D. S. S. & A. Railways to Presque Isle and Escanaba, and thence by boat to lower lake ports.

Operating Company: Iron Cliffs Co., Ishpeming, Mich.

Manager: M. M. Duncan.

Superintendent: Lucian Eaton.

Sales Agents: Cleveland Cliffs Iron Co., Cleveland, Ohio.

```
Yearly Shipments:
                                                 1883-- 17,028 tons
              Salisbury
                                                       - 26,629 tons
- 29,503 tons
          1872-
                    440 tons
                                                  1884
          1873-
                - 11,023 tons
                                                  1885
                                                       - 51,667 tons
          1874-
                 7,480 tons
                                                  1886-
          1875
                  4,330 tons
                                                  1887-
                                                       - 48,304 tons
          1876— 20,315 tons
                                                  1888
                                                         74,947 tons
               - 37,660 tons
                                                  1889— 72,449 tons
1890— 85,798 tons
                                                 1889
          1877-
          1878-
                - 52,155 tons
                - 39.293 tons
          1879-
                                                  1910-
                                                       - 85,098 tons
          1880-21,457 tons
                                                 1911— 91,334 tons
          1881-43,690 tons
                                                 1912-161,068 tons
                                                 1913-
          1882— 42,243 tons
                                                       – 46,095 tons
                       Total, Tons......1,070,006
Analysis:
             The average of all cargo analyses for 1913 is as fol-
            Dried at 212° F.
    lows:
  Salisbury:
             Phos.
    Iron
                    Silica
                              Mang.
                                      Alum.
                                               Lime Magnes. Sulph.
                                                                          Loss
    58.83
                      7.11
                              .570
             .101
                                       2.86
                                                 .71
                                                         1.00
                                                                  .080
                                                                          2.28
  Clinton:
                              Mang.
             Phos.
                     Silica
    Iron
                                      Alum.
                                               Lime Magnes. Sulph.
                                                                          Loss
    60.40
             .202
                      6.83
                              .210
                                       2.77
                                                 .60
                                                          .17
                                                                  .012
                                                                          2.43
 Clinton Silica:
                              Mang.
                     Silica
    Iron
             Phos.
                                      Alum.
                                               Lime Magnes. Sulph.
                                                                         Loss
                     20.59
    51.10
             .075
                              .200
                                       2.02
                                                .34
                                                          .23
                                                                 .008
                                                                          3.45
    The ore in its natural state is as follows:
 Salisbury:
    Moist
           Iron
                  Phos.
                          Silica
    13.60
            50.83
                    .087
                            6.14
  Clinton:
    Moist
            Iron
                  Phos.
                          Silica
    11.85
            53.24
                    .178
                            6.02
 Clinton Silica:
    Moist Iron
                  Phos.
                          Silica
    11.90
            45.02
                    .066
                           18.14
```

SOUTH JACKSON MINE.

Location: Marquette County, Michigan, Section 1, Township 47, Range 27.

Description: A part of the old JACKSON MINE, renamed in 1913. The ore is a red, soft-silicious, hard, Hematite, and is crushed. The mine is worked by the open-pit method, the greatest vertical depth being 50 feet. The ore is shipped via the L. S. & I. and the C. & N. W. Railwavs to Presque Isle and Escanaba, and thence by boat to lower lake ports.

and Escanaba, and thence by boat to lower lake ports.

Operating Company: The Jackson Iron Co., Ishpeming, Mich.

Manager: M. M. Duncan.

Superintendent: S. R. Elliot.

Sales Agents: The Cleveland Cliffs Iron Co., Cleveland, Ohio.

Yearly Shipments: See NORTH JACKSON MINE.

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 40.45 1.03 34.20 2.34 1.03 .58 .47 .033 2.87

The ore in its natural state is as follows:

Moist Iron Phos. Silica 7.25 37.52 .096 31.72

STAR WEST MINE (Formerly Wheat Mine).

Location: Marquette County, Michigan, Section 29, Township 47, Range 26.

Description: First opened up in 1879. Ore is a soft, blue, silicious, Bessemer Hematite. Ore is crushed.

It is an underground mine.

Sales Agents: Corrigan, McKinney & Co., Cleveland, Ohio.

Yearly Shipments:

1879— 851 tons 1880— 3,323 tons 1881— 9,040 tons	1892— 1893— 1894— 5,550 tons
1882— 9,554 tons	1895— 51,207 tons
1883— 6,625 tons	1896— 9,658 tons
1884— 6,824 tons	1897— 942 tons
1885— 9,200 tons	1898—
1886— 15,867 tons	1899— 6,716 tons
1887— 17,538 tons	1900— 15,987 tons
1888— 4,987 tons	1911— 4,466 tons
1889— 7,997 tons	1912—
1890— 15,141 tons	1913—
1891— 4,412 tons	
Total,	Tons209,115

Analysis: The expected analysis for 1914 is as follows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 55.15 .036 15.60 .15 .90 1.40 1.22 .003 1.00 The ore in its natural state is as follows:

Moist Iron Phos. Silica

2.60 53.72 .035 15.19

STEGMILLER MINE.

Location: Marquette County, Michigan, Section 17, Township 45, Range 25.

Description: First opened up in 1909. Ore is hard and soft, silver-blue, Non-Bessemer Hematite. Ore is not crushed. The mine is worked by underground methods. Greatest vertical depth is 297 feet. The ore is shipped via the C. & N.

W. Railway to Escanaba, and thence by boat to lower lake

Operating Company: The Oliver Iron Mining Co., Swanzy, Mich.

General Manager: J. H. McLean.

General Superintendent: W. H. Watson.

Yearly Shipments:

1909— 39,869 tons 1912— 50,963 tons 1910— 48,842 tons 1911— 45,122 tons

Total, Tons......230,227

Analysis: The average of all cargo analyses for 1913 is as fol-

lows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 58.61 .533 7.83 .505

The ore in its natural state is as follows:

Moist Iron Phos. Silica 14.46 50.13 .456 6.70

STEPHENSON MINE.

Location: Marquette County, Michigan, Section 20, Township 45, Range 25.

Description: First opened up in 1904. The mine ships three grades of ore: STEPHENSON, a soft, Non-Bessemer Hematite; STEPHENSON-BESSEMER, a soft, Bessemer Hematite; and STEPHENSON NO. 2, a Non-Bessemer Hematite. The ore is not crushed. The mine is worked by the caving system, the greatest vertical depth being 560 feet. The ore is shipped via the M. M. & S. E. and the C. & N. W. Railways to Presque Isle and Escanaba, and thence by boat to lower lake ports.

Operating Company: The Cleveland Cliffs Iron Co., Ishpeming, Mich.

Manager: M. M. Duncan. Superintendent: G. R. Jackson.

Sales Agents: The Cleveland Cliffs Iron Co., Cleveland, Ohio.

Yearly Shipments:

1907— 6,305 tons 1911—128,839 tons 1908— 52,588 tons 1912—214,386 tons 1909— 64,075 tons 1910—225,726 tons

Total, Tons......788,198

Analysis: The average of all cargo analyses for 1913 is as fol-

lows: Dried at 212° F.

Stephenson: Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss Iron 2.12 59.52 .300 6.72 .50 .86 .78 .017 2.11 The ore in its natural state is as follows:

Stephenson:
Moist Iron Phos. Silica
13.85 51.28 .258 5.79

VOLUNTEER MINE (Maitland Shaft).

Marquette County, Michigan, Section 30, Township 47, Range 26.

Description: First opened up in 1871. This mine ships three ores: PALMER, soft, brown, Bessemer Hematite; CAS-CADE, soft, brown, Non-Bessemer Hematite; and WARNER, soft, brown, silicious Bessemer Hematite. The caving system of mining is now used. The greatest vertical depth is 543 feet. The ore is shipped via the Duluth, South Shore & Atlantic Railway to Marquette and from there to the lower lake ports by boat.

Operating Company: Volunteer Ore Company, Negaunee, Mich. Superintendent: Thomas Pellow.

Sales Agents: Pickands, Mather & Co., Cleveland, Ohio.

Yearly Shipments:

```
1892—127,130 tons
        4,171 tons
1872— 39,495 tons
                                            1893-
                                                  - 69.561 tons
                                            1894
1873— 41,204 tons
                                                  – 26,946 tons
                                            1895
1874— 16,106 tons
                                                   - 32,672 tons
1875—
                                            1896-
         4,070 tons
                                                  – 53,216 tons
1876— 15,324 tons
                                            1897-
                                                     1,617 tons
1877— 20,211 tons
1878— 5,929 tons
                                            1898
                                            1899-
                                                  - 29,983 tons
1879--- 24,663 tons
                                            1900-47,578 tons
1880— 38,881 tons
                                            1901
                                            1902- 32,736 tons
1881— 39,276 tons
                                                  - 7,395 tons
- 71,870 tons
1882
      - 41,456 tons
                                            1903-
1883-19,414 tons
                                            1904-
                                            1905—106,281 tons
1906— 38,544 tons
1907— 10,022 tons
1884
      - 11,748 tons
1885
         5,679 tons
1886— 24,034 tons
1887— 47,486 tons
                                            1910-
1888— 56.321 tons
                                            1911— 51,240 tons
1889— 60,156 tons
1890—141,524 tons
                                            1912— 9,008 tons
                                            1913-47,698 tons
1891- 92,699 tons
              Total, Tons..........1,527,143
```

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Palmer:

Iron 61.50	Phos041	Silica 7.00	Mang. .68	Alum. 1.40	Lime .38	Magnes.	Sulph. .038	Loss 1.40
Cascade: Iron 58.20	Phos056	Silica 12.00	Mang. .55	Alum. 1.20	Lime .51	Magnes.	Sulph. .040	Loss 1.60
*Warner:								
Iron 52.50	Phos. .046	Silica 18.40	Mang. .65	Alum. 1.42	Lime .50	Magnes.	Sulph. .075	Loss 1.70

The ore in its natural state is as follows: Palmer: Moist Iron Phos. Silica 11.00 54.74 .036 6.23 Cascade: Moist Iron Phos. Silica 11.00 51.80 .049 10.68 *Warner: Moist Iron Phos. Silica 47.25 10.00 .041 16.56

WASHINGTON MINE.

Marquette County, Michigan, Section 11, Township Location: 47, Range 29 West.

Description: First opened up in the early sixties. The mine ships four grades of ore: WASHINGTON, WASHINGTON NO. 2, WASHINGTON SILICIOUS, and WASHINGTON LUMP; crushed to one-inch size. All of these grades are hard, steel-gray, Non-Bessemer, Specular Hematites. The mine is worked by the back-stoping system, the greatest vertical depth being 580 feet. The ore is shipped via the D. S. S. & A. Railway to Marquette, and thence by boat to the lower lake ports. Old name, Barron Mine. Operating Company: Washington Iron Co.

Manager: E. N. Breitung, 11 Pine St., New York, N. Y.

Superintendent: W. B. Pattison, Negaunee, Mich. Sales Agents: E. N. Breitung & Co., Cleveland, Ohio.

Yearly Shipments:

*Expected analysis, 1914.

omhinento.	
Humbolt	1881— 26,302 tons
1865— 4,782 tons	1882— 43,463 tons
1866— 15.150 tons	1883— 31,866 tons
1867— 25.440 tons	1884— 23,763 tons
1868— 35,757 tons	1885— 11,766 tons
1869— 58,462 tons	1886— 20,207 tons
1870— 79,762 tons	1887— 19,873 tons
1871— 48.725 tons	1888— 11,655 tons
1872— 38,841 tons	1889— 15,866 tons
1873— 38.014 tons	1890— 23,259 tons
1874— 27,890 tons	1891— 19,879 tons
1875— 9,642 tons	1892— 4.571 tons
1876— 3,333 tons	1893—
1877— 16,545 tons	1894—
1878— 33.920 tons	1895—
1879— 18.204 tons	1896— 2,297 tons
1880— 14.726 tons	1090— 2,297 tons
	Tama 722 061
Total,	Tons723,961
Washington	1911— 62,592 tons
1908— 20,625 tons	1912— 66,749 tons
1909— 44,716 tons	1913— 60,581 tons
1910— 96,769 tons	,
	Tons352,032

The average of all cargo analyses for 1913 is as follows: Dried at 212° F. Washington: Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss Iron 59.91 .145 9.98 .06` .019 .08 1.33 .60 .25 Washington No. 2: Mang. Alum. Phos. Silica Lime Magnes. Sulph. Loss Iron .137 1.26 57.33 15.62 .08 .68 .33 .007 .03 Washington Silicious: Alum. Lime Magnes. Sulph. Iron Phos. Silica Mang. Loss 45.75 .100 29.50 1.90 .10 .88 .62 .031 .42 Washington Lump: Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 62.50 .128 9.05 .12 .76 .28 .10 .028 The ore in its natural state is as follows: Washington: Phos. Silica Moist Iron 59.35 .93 .143 9.88 Washington No. 2: Moist Iron Phos. Silica .94 56.82 15.47 .135

WEBSTER MINE.

Silica

29.06

Silica

9.00

.098

Phos.

.127

Location: Baraga County, Michigan, Section 26, Township 48, Range 31.

Description: First opened up in 1889. The ore is a Non-Bessemer Limonite, and is not crushed. The mine is worked by the open-pit method, the greatest vertical depth being 500 feet. The ore is shipped via the D. S. S. & A. Railway to Marquette, and thence by boat to lower lake ports.

Operating Company: The Cleveland Cliffs Iron Co., Ishpeming, Mich.

Manager: M. M. Duncan. Superintendent: L. Eaton.

Washington Silicious:

Washington Lump: Moist Iron

1.50

.52

Moist Iron Phos.

45.06

62.17

Analysis:

Sales Agents: The Cleveland Cliffs Iron Co., Cleveland, Ohio.

BARABOO DISTRICT

ILLINOIS MINE.

Location: Sauk County, Wisconsin, Section 15 and 16, Township 11 North, Range 5 East.

Description: First opened up in 1904. The ore is soft, red, Bessemer Hematite. Underground system of mining is used. The greatest vertical depth is 475 feet. Mine has been idle since 1908.

The ore was shipped via Chicago & Northwestern Railway to the furnace.

Owners: Illinois Iron Mining Co.

Yearly Shipments:

1904— 47,922 tons	1909
1905— 71,413 tons	1910—
1906— 67,118 tons	1911—
1907— 72,180 tons	1912—
1908— 51,108 tons	1913—
Total	, Tons309,741

MAYVILLE DISTRICT

IRON RIDGE MINE.

Location: Dodge County, Wisconsin, Sections 1, 12, 13, 16 and 36, Townships 11 and 12, Range 16.

Description: First opened up in 1903. The ore is soft, yellowish-brown, Non-Bessemer Hematite and is not crushed.

The mine is worked by underground methods.

The ore is shipped via the C. M. & St. P. Railroad to Escanaba, and thence by boat to lower lake ports.

Operating Company: Oliver Iron Mining Co., Iron Ridge, Wis. General Manager: J. H. McLean.

General Superintendent: O. C. Davidson.

Yearly Shipments:

•	
1903— 17,913 tons	1909— 15,955 tons
1904— 19,558 tons	1910— 14,487 tons
1905— 39,978 tons	1911— 17,002 tons
1906— 61,634 tons	1912— 19.284 tons
1907— 3,966 tons	1913— 26,213 tons
1908	•

Total, Tons......235,980

Analysis: The average of all cargo analyses for 1913 is as fol-

lows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 45.64 1.62 5.57

MAYVILLE MINE.

Location: Dodge County, Wisconsin, Section 12, Township 11, Range 16.

Description: First opened up in 1893. The ore is a soft, red and brown, Non-Bessemer Hematite.

The mine is now worked by underground methods. Pit mine is worked out. The greatest vertical depth is 125 feet. The ore is shipped via the C. M. & St. P. Railroad to the Mayville Furnace Co.

Operating Company: Northwestern Iron Co., Milwaukee, Wis. Manager: J. H. Means.

Superintendent: J. P. O'Connor.

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Yearly Shipments:
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```
Prior to 1893— 9,044 tons
1893— 7,925 tons
1894— 10,511 tons
1895— 16,472 tons
                                                                 1903— 18,836 tons
1904— 26,562 tons
1905— 20,610 tons
                                                                 1906— 15,847 tons
1896— 13,144 tons
1897— 10,546 tons
1898— 18,151 tons
                                                                 1907— 19,644 tons
1908— 71,341 tons
1909— 66,804 tons
                                                                           - 77,195 tons
 1899— 19,731 tons
                                                                  1910-
1911— 98,627 tons
1912— 84,747 tons
1913—118,797 tons
```

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Lime Magnes. Sulph. 6.40 3.72 .024 Phos. Silica Mang. Alum. Iron Loss 1.13 4.75 .14 4.05 45.53 12.35

The ore in its natural state is as follows:

Moist Iron Phos. Silica 11.25 40.40 1.00 4.22

MICHIPICOTEN RANGE

HELEN MINE.

Location: District of Algoma, Province of Ontario, Canada; Township 29, Range 24.

Description: First opened up in 1899. The ore is a hard, red, Non-Bessemer Hematite, and is crushed. The mine is worked by back-caving from sub-levels, the greatest vertical depth being 650 feet. The ore is shipped via the Algoma Central Railroad to Michipicoten Harbor, and thence by boat to lower lake ports.

Operating Company: Algoma Steel Corporation, Ltd., Sault Ste. Marie, Ontario, Canada.

General Superintendent: A. Hasselbring.

Superintendent: A. A. Mackay.

Yearly Shipments:

DP	
1900— 65,000 tons	1907—142,832 tons
1901—232,531 tons	1908—148,421 tons
1902—302,510 tons	1909—170,065 tons
1903—203,119 tons	1910—115,790 tons
1904—118,355 tons	1911—148,627 tons
1905—169,527 tons	1912— 48,838 tons
1906—121,556 tons	1913— 41,497 tons
* Total.	Tons2,028,668

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Helen No. 1:

 Iron
 Phos.
 Silica
 Mang.
 Alum.
 Lime
 Magnes.
 Sulph.
 Loss

 58.63
 .091
 4.46
 .16
 .88
 .23
 .14
 .204

Helen No. 2:

 Iron
 Phos.
 Silica
 Mang.
 Alum.
 Lime
 Magnes.
 Sulph.
 Loss

 57.76
 .092
 5.90
 .16
 .88
 .23
 .14
 .391

The ore in its natural state is as follows:

Helen No. 1:

Moist Iron Phos. Silica 5.20 55.58 .086 4.23

Helen No. 2:

Moist Iron Phos. Silica 4.00 55.45 .088 5.66

MAGPIE MINE.

Location: District of Algoma, Province of Ontario, Canada, Township 29, Range 26.

Description: First opened up in 1911. The ore is a Bessemer Siderite, calcined and roasted, producing a nodulized ore. The mine is worked by back-stoping from sub-levels, the greatest vertical depth being 250 feet. The ore is shipped

via the Algoma Central Railroad to Michipicoten Harbor, and thence by boat to lower lake ports.

Operating Company: Algoma Steel Corporation, Ltd., Sault Ste. Marie, Ontario, Canada.

General Superintendent: A. Hasselbring.

Sales Agents: M. A. Hanna & Co., Cleveland, Ohio.

Yearly Shipments:

19**11**— 19121913--- 20,000 tons

Total, Tons......20,000

Analysis: The expected analysis for 1914 is as follows: Dried at 212° F.

Iron Phos. Silica Mang. Alum. Lime Magnes. Sulph. Loss 51.60 .010 7.42 2.92 .62 8.55 8.25 .123 None The ore in its natural state is as follows:

Moist Iron Phos. Silica .50 51.34 .010 7.42

MOOSE MOUNTAIN DISTRICT

MOOSE MOUNTAIN MINE.

Location: Hutton Township, Province of Ontario, Canada.

Description: This mine was first opened up in 1908. The mine ships two grades of ore: MOOSE MOUNTAIN BRI-QUETTES, which are made by the Grondal Process, and are hard, gray, Bessemer Hematite, the finished Briquettes being 3 in. by 3 in. by 6 in. in size; and MOOSE MOUNTAIN, which is crushed and screened to a maximum size of one inch, and also magnetically concentrated, and is a hard, gray, Non-Bessemer Magnetite. The mine is worked by a shaft and open-pit, the greatest vertical depth being 150 feet in the shaft. The ore is shipped via the Canadian Northern Ontario Railroad to Key Harbor, Ontario, and thence by boat to lower lake ports.

Operating Company: Moose Mountain, Ltd., Whitehall Bldg., New York City.

Manager: C. E. Hermann.

Superintendent: F. A. Jordan.

Sales Agents: Oglebay, Norton & Co., Cleveland, Ohio.

Yearly Shipments:

1908— 2,557 tons 1911— 6,749 tons 1909— 26,199 tons 1912— 49,339 tons 1910— 71,784 tons 1913— 95,518 tons Total, Tons......252,146

Analysis: The average of all cargo analyses for 1913 is as follows: Dried at 212° F.

Briquettes:

 Iron
 Phos.
 Silica
 Mang.
 Alum.
 Lime
 Magnes.
 Sulph.
 Loss

 63.03
 .028
 6.05
 .06
 .93
 2.00
 1.49
 .014

Moose Mountain:

 Iron
 Phos. Silica
 Mang. Alum.
 Lime Magnes. Sulph.
 Loss 54.61

 54.61
 .099
 14.65
 .09
 2.03
 3.26
 3.06
 .027
 .42

The ore in its natural state is as follows:

Briquettes:

Moist Iron Phos. Silica .83 62.51 .028 6.00

Moose Mountain:

Moist Iron Phos. Silica .52 54.33 .098 14.57

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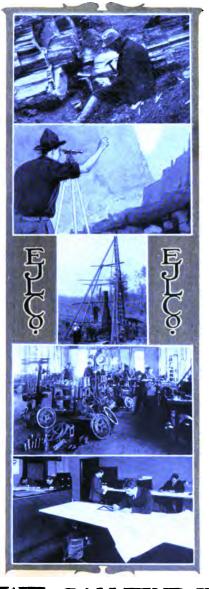
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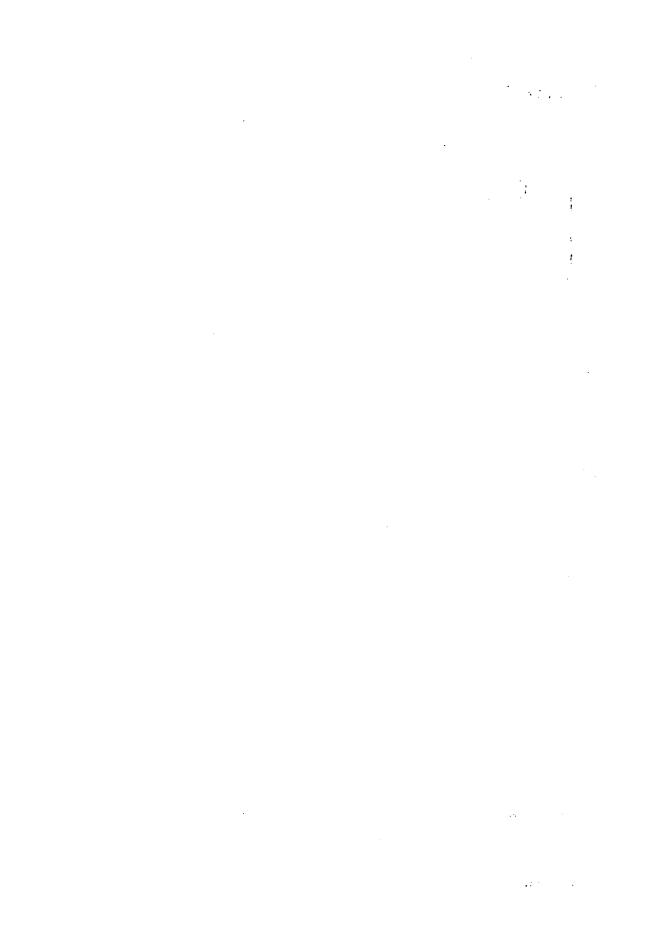
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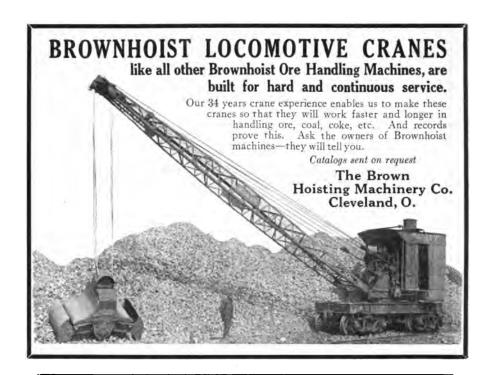
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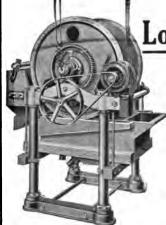
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